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Engineering News-Record

In this issue . . .

Fundamental Principles of Soil Compaction
First of Four Articles on the Design and Construction of Rolled Earth Dams

Buying to Insure Greatest Profit
Fourth of a Series of Articles on Business Problems of Contracting

Testing Machine Capacity Doubled by Special Loading Rig

Concrete Caissons Sunk by Air-Lift Pumping

Spring-Summer Operation at Lake Michigan Filter Plants

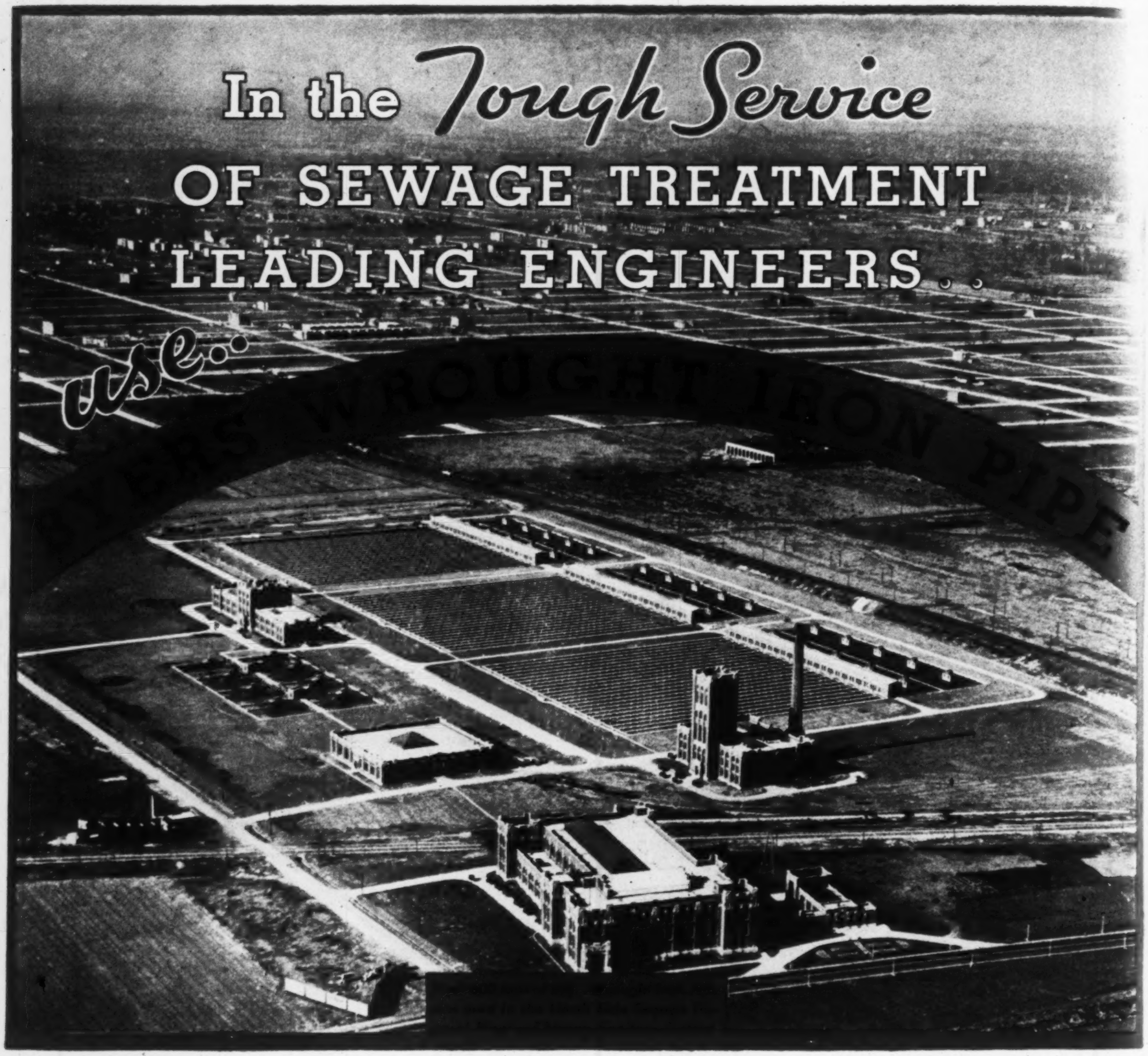
North Platte Irrigation Financed by NRA

Reinforced Brick Walls Reduce Steel Work

Gunite Retains Integrity of Oregon Road Bridge

. . . Also in this issue . . .

The Yellow River—China's Flood Menace



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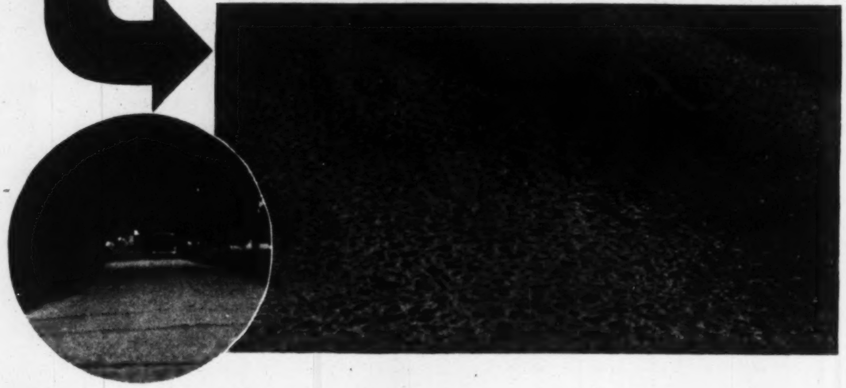

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First of Four Articles on the Design and Construction of Rolled-Earth Dams

Fundamental Principles of Soil Compaction

By R. R. Proctor

Field Engineer, Bureau of Waterworks and Supply, Los Angeles, Calif.

THIS IS the first of four articles describing the application to the design and construction of rolled-earth dams of recently developed methods for controlling the compaction of soils. Under the new procedure a series of simple laboratory and field tests determines the suitability of the available soils, supplies essential data for the design of the dam, serves as a basis for the control of construction operations and furnishes a definite check on the effectiveness of the work as it proceeds. Methods are described for compacting soils so that they will be sufficiently watertight and will not become soft and unstable if completely saturated with water. The basic principles of the control of soil compaction that are described apply to all types of earthfills and to foundation design as well as to earth dams. —EDITOR.

THE NEED of a more precise procedure for the design and construction of earthfill dams initiated an extensive investigation by the Bureau of Waterworks and Supply of the city of Los Angeles into the suitability of various soils for this use, and a search for new methods of construction control that would be more certain in their application to the work than any that were available. It was particularly desired to find some method for determining and limiting the softening of an earthfill dam that may occur, under certain conditions, if the soils contained in it become completely saturated with percolating water.

The investigation resulted in the development of an entirely new method of procedure in the engineering control of earth-dam design and construction. The procedure has been further perfected in connection with the construction of four dams in the past two years, three of which are completed and in service. It is now in constant use in the construction of the Bouquet Canyon Dam No. 1, a compacted earthfill structure that will have a depth of fill of 221 ft.

As developed, the new procedure is a system of field and laboratory controls designed to secure the compaction of the soils to the density which, by actual test, is determined essential to obtain the required watertightness and stability in the dam. The required soil density is obtained by controlling the design and use of the compacting equipment and by placing the correct moisture content in the soil before it is compacted. Precise methods are provided for testing the compacted soils, as the work progresses, to determine their watertightness and stability under conditions similar to those in the finished structure. Similar tests may be made on foundation soils upon which the dam is to be constructed, thereby enabling the engineer to direct the removal of those soils found unsuitable. The methods described also apply to any earthfill, for any purpose, that is to be compacted to reduce settlement or softening from partial or complete water saturation.

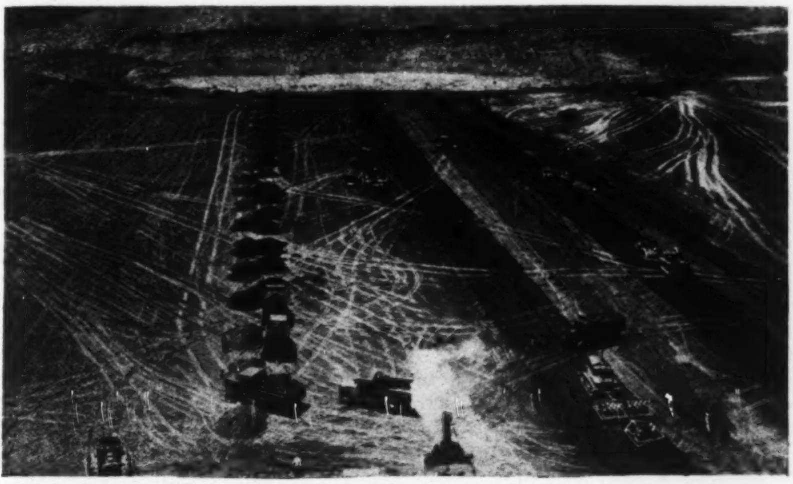


Fig. 1—Placing compacted earthfill in Los Angeles' Bouquet Dam No. 1. Five sheepsfoot rollers of special design are used to compact the soil, and one is used to remove concentrated truck tracks. The soil is spread in loose layers of sufficient thickness to result in a 6-in. compacted layer.

Soils are composed of many shapes and sizes of sand, silt or clay particles that do not fill all of the space occupied by the soil. The space between the particles is known as the voids or porosity; both are expressed as their percentage of the total soil volume. The extent to which the smaller particles occupy the spaces between the larges ones determines the total quantity of soil particles that occupy a given volume, which determines the soil density and the voids. Soils are compacted by forcing the smaller particles to move into the spaces between the larger ones, thus increasing the soil density and decreasing the voids. The compacting force must overcome the frictional resistance between the soil particles in order to move them. The effectiveness of any method for compacting a soil is therefore limited by the friction between the particles. This will be shown to be determined by the moisture content of the soil.

Plasticity of soils

The plasticity of a soil is determined by the frictional resistance between its particles. It is known that the addition of water to a soil that is not already saturated makes it more plastic. The water added to a soil displaces air in the voids and has an effect similar to that of lubrication. The moisture contained in a very dry soil surrounds each particle as a thin film held in place by the force of surface tension. Where the films come in contact, the capillary force caused by the surface tension of the joined films draws the particles firmly together, causing a high frictional resistance between them. This effect may be seen by placing a few fine soil particles in water suspension on a glass slide and observing them under the microscope as the water evaporates. Small angular particles, composed of such materials as quartz, may be seen firmly attached to the glass slide by the force of capillarity, when the water has evaporated to the fullest extent possible without the application of heat. A full discussion of the effect of the surface tension of the water in soils may be found in the article "Principles of Soil Mechanics" by Dr. Charles Terzaghi (*ENR*, Nov. 5, 1925, p. 742).

The addition of water to a very dry soil reduces the capillary force, which has two effects; the particles spring apart slightly, due to the reduction of the capillary force, and the frictional resistance between them is reduced. The soil is then more plastic and has expanded slightly in volume. This effect continues with the addition of water to the soil until the forces of capillarity are almost entirely released and no further soil expansion occurs. The quantity of water in the soil when this condition is reached is not sufficient to fill the voids. The addition of still more water tends to lubricate the soil further, but no more expansion occurs. The limit of lubrication of the particles is reached when the voids become filled with water; the friction between the particles cannot then be further reduced without rearranging them so as to increase the voids and permit the soil to absorb more water.

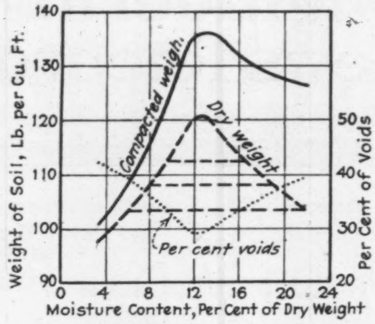


Fig. 2—Graph showing the effect of moisture content on the compacted weight, dry weight and voids of a soil when compacted by a particular method.

The limit of softening in a confined soil is therefore reached when the voids become filled with water and the soil is fully saturated. A particular soil may be compacted to many different densities and percentages of voids; obviously, there are then many degrees of softening that can take place from saturation due to this variation in water content necessary for complete saturation. Therefore, the extent to which the voids in a soil are reduced by compaction determines the softening that can take place from water saturation.

The soils in an earth dam may become fully saturated with percolating water; therefore, it is essential for the engineer to determine the density that is required to obtain the necessary stability in a particular soil before it is compacted in a dam. After the required soil density has been ascertained, an adequate process for securing it must be used, and facilities should be available for precise determination of the effectiveness of the work as it proceeds.

Moisture effect on compacted density

The effect of the moisture content of a soil upon the density to which it may be compacted is the most important principle of soil compaction. The discussion and conclusions that follow are based on data obtained from laboratory compaction tests on more than 200 different soils, each of which was compacted at several moisture contents by the same process. The laboratory methods are known to duplicate the results obtained by compacting the soil with certain types of construction equipment. The soils varied in grading from a silty gravel, 8 per cent of which passed the 200-mesh sieve, to a fine clay, 92 per cent of which passed that sieve. The results of the laboratory tests have been verified by many field tests during the construction of the dams previously mentioned.

The compaction of a soil at a very low moisture content may result in a hard and firm fill having practically n plasticity. Compacting the soil by th same method but with a slightly high moisture content causes a greater r arrangement of the various-sized so particles with the same effort, due t the increased lubrication furnished b the additional water. The result is soil of greater density that contains les voids and is more plastic. This effec continues until the moisture conten plus a small amount of contained ai that the compaction process cannot re move, becomes just sufficient to fill th voids when the compaction process i completed.

The soil now has the greatest densit and the least voids that this method o compaction can obtain; further reduction of the voids is impossible without forcing out some of the water or contained air. It has not been found possible to do this with any construction equipment available. A higher moisture content limits the compaction of the soil to a point at which the voids equal the volume of the contained air and water, resulting in a compacted soil with more voids, less density and increased plasticity. This effect continues with the addition of more water until the soil becomes too plastic to sustain compacting equipment.

It is now evident that the moisture content of a soil, when it is being compacted, controls the soil density and consequent voids that can be attained by a particular method of compaction. The compacted soil containing the least voids will require less water to saturate it; therefore, when it is saturated it will have less lubrication between the soil particles and consequently less plasticity and greater stability. Therefore, the most stable dam that can be constructed, by use of a particular method of compacting the soils, will be obtained if the soils contain the moisture content that results in the least voids when they are compacted.

The voids are the channels of flow for percolating water; reducing them to a minimum, by compacting the soil at the proper moisture content, reduces the flow of water to the minimum attainable with the process of compaction used. Therefore, the use of the soil-moisture content that obtains the least voids with a particular method of compaction results in the most watertight and stable dam that the method of compaction can secure.

The use of still greater compacting forces and a correspondingly lower soil-moisture content results in a dam with increased soil density, decreased voids, increased watertightness, less capacity for water absorption, less plasticity and increased stability; the soil particles are arranged in closer contact by the greater force, with less water for a lubricant. Increased watertightness and stability are thus obtained by increasing the weight of construction equipment used for compacting the soil. The proper type of construction equipment, as well as the correct moisture in the soil, must therefore be used to obtain a desired degree of watertightness and stability in a dam.

The dry-weight curve

The curves of Fig. 2 were plotted from data secured by compacting a sandy clay soil at thirteen different moisture contents. The same method of compaction was used in each case. This compaction method is known to be equivalent to the use of a certain type of construction equipment. The compacted-weight curve shows the weight of soil per cubic foot after it was compacted at the indicated moisture contents. The dry-weight curve was obtained by deducting the weight of the contained moisture from the compacted weight per cubic foot. It therefore shows the actual weight of the soil particles in a cubic foot of soil that was compacted at the indicated moisture contents. The per-cent-of-voids curve, determined by the dry weight and specific gravity of the soil, shows the voids in the soil after it was compacted at the indicated moisture contents. The dry-weight curve is customarily used to show the characteristics of compacted soils, the other curves are given in order to show their relation to the dry-weight curve.

The plasticity of the thirteen compacted-soil specimens plotted in Fig. 2 was determined by measuring their resistance to penetration with an instrument designed for this purpose. Its design and method of use will be discussed later; for the present the penetrating pressures will be expressed as the pressure required to force a lead pencil, with an end area of 0.1 sq.in., to penetrate the compacted soil at a rate of about ½ in. per second.

The extent that the voids in this soil may be reduced by compacting at the proper moisture content is clearly shown. The compacted soil that contains the least voids is necessarily the most watertight. The compacted soil that contains the least voids cannot absorb as much water as the others; therefore, this soil will soften less from water absorption.

The soil had the same dry weight and voids when compacted at 6.2 and 22.0 per cent moisture contents. The plasticity of the two compacted soils was very different: the one containing 6.2 per cent moisture was very hard; and the other, containing 22 per cent moisture, was of about the consistency of soft putty. The pressure required for a pencil to penetrate the soil compacted at 6.2 per cent moisture content was 1,000 lb., the pressure required for the one compacted at 22 per cent moisture content was 0.8 lb. The same dry weight and voids in the two compacted soils determine that they can absorb the same quantity of water; therefore the soil that was compacted at 6.2 per cent moisture content can become similar to that which was compacted at 22 per cent moisture content by water absorption. This is the explanation of the extreme softening of compacted soils that sometimes occurs when they become saturated with water.

The soil in an earth dam is subject to partial or complete saturation by percolating water; for this reason the soil that was compacted at 6.2 per cent moisture content should be considered similar in every respect to that which was compacted at 22 per cent moisture content. The first consideration of any compacted specimen of this soil should be made by determining its dry weight and noting the position of this value on the dry-weight curve to the right of the point of maximum dry weight. It is definitely known that it can absorb at least this quantity of water. The remaining capacity for water absorption can be computed from the voids. A direct method for obtaining the capacity of compacted soils to absorb water will be discussed in connection with Fig. 6—in the second article.

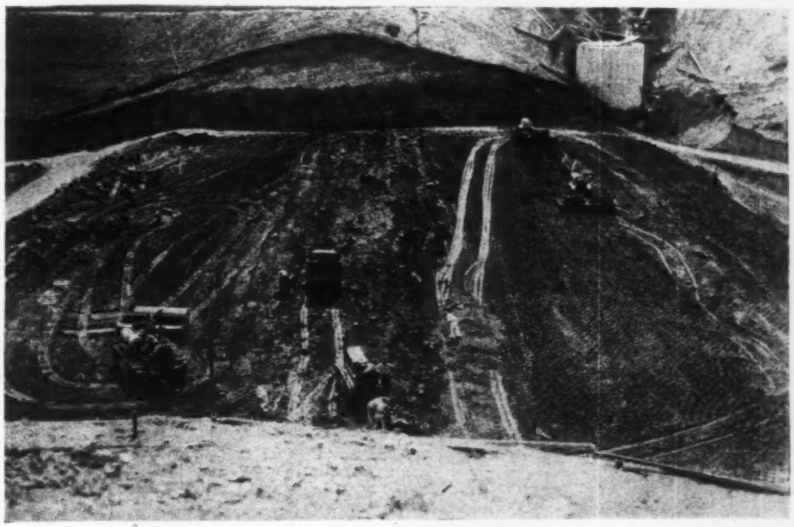


Fig. 3—Placing compacted earthfill at Upper Hollywood Reservoir, recently completed by the city of Los Angeles. The soil shown in the center of the picture was successfully compacted by the methods described, after removing the rocks larger than 5 in. in diameter.

Compacting at low moistures

A moisture content of about 8 per cent permits rolling the soil used in preparation of Fig. 2 so dry that it will not spring under the roller. The resulting fill appears to be well compacted; it is firm and hard. The soil, when compacted at 8 per cent moisture, weighs 116.6 lb. per cubic foot, has a dry weight of 108 lb. and contains 36.5 per cent voids. It requires about 500-lb. pressure to force a lead pencil into this compacted soil. This same dry weight may be obtained by compacting the soil at 19.2 per cent moisture. The compacted weight is then 128.6 lb. per cubic foot. The increase in compacted weight of 12 lb. is caused by the increased water content. This quantity of water could be absorbed in the soil that was compacted at 8 per cent moisture without any change in the soil volume or voids. A pressure of 2 lb. would be required to force a lead pencil into this soil when compacted at 19.2 per cent moisture content. The pressure required for a pencil to penetrate the soil compacted at 8 per cent moisture should therefore be considered subject to a reduction from 500 lb. to 2 lb., or less, if the soil becomes saturated. This is not a sufficiently stable soil condition in a dam.

Compacting at high moistures

It may now be seen that it is possible to compact a soil so firm and hard as to appear entirely suitable for a dam and for this same soil to become very soft and unstable when percolating water saturates it. A compacted soil firm enough to require a pressure of about 15 lb. to force a lead pencil into it is required to prevent the wheels of a loaded truck from sinking into it. This condition is obtained in this soil at 16.5 per cent moisture content, when it is compacted by the method used in preparation of Fig. 2. Therefore, if a dam is to be built by hauling the soil in trucks and compacting it with construction equipment of the type represented by Fig. 2, the moisture content cannot be more than 16.5 per cent, which establishes a minimum dry weight of 112.5 lb.

It is now seen in this case that better results can be obtained by compacting this soil so wet and soft that it will barely support trucks than by compacting it so hard that it will not spring under the roller. The benefit would be an increase in dry weight from 108 to 112.5 lb. A dry weight of 112.5 lb. may also be obtained by using a moisture content of 9.5 per cent. About

200-lb. pressure would be required to force a pencil into the soil if compacted at this moisture. As the final results of compacting at the two moistures would be the same dry weight of soil, it would be best to compact the more plastic soil at 16.5 per cent moisture; the resulting fill would probably be more uniform in density. If more moisture than 16.5 per cent were placed in the soil, it could not be compacted sufficiently, because of this excess moisture, to permit truck travel over it, and the work could not proceed. If the moisture content were slightly less, the fill would be denser and more suitable, as shown in Fig. 2.

This shows that a soil may be compacted so as to be very plastic and have the appearance of being too soft for use in a dam, and still it may be superior to that which is compacted very firm and hard with a moisture content low enough to prevent springing under the roller. More than 200 compaction curves that have been experimentally determined, together with many field measurements, verify this conclusion.

The compaction of this soil at a moisture content of 12.5 per cent is shown by Fig. 2 to result in a dry weight of 121 lb. per cubic foot; this is the maximum compaction attainable with this type of equipment. The compacted soil contains 28.5 per cent voids. A pressure of approximately 100 lb. would be required to force a pencil into the compacted soil. Although this compacted soil is much more plastic than that which was compacted at 8 per cent moisture, one-fifth of the pressure being required for penetration, it contains 13 lb. more soil to the cubic foot. The voids are thereby reduced from 36.5 to 28.5 per cent, greatly increasing the watertightness and stability.

Determination of saturated plasticity

The saturated moisture content of this soil at its maximum dry weight of 121 lb. is 15 per cent, representing an increase in moisture content of 2.5 per cent over the 12.5 per cent moisture required for maximum compaction. This quantity of water is that necessary to replace the air which compaction does not remove from the soil particles. This contained air, for this particular soil, is equivalent to 2.5 per cent moisture at the peak of the curve and to 1 per cent moisture at 22 per cent moisture content. A specimen of this soil, which was compacted at 15.7 per cent moisture and contained the same quantity of water as the 121-lb. maximum dry-weight specimen when saturated but with a dry weight that was 6 lb. less, required 24 lb. pressure to force a pencil into it. Obviously the saturated soil of 121-lb. dry weight, containing the same quantity of water and 6 lb. more of soil particles, would be much firmer. The same computation establishes a required force of 1 lb. to force a pencil into the specimen of this soil that was compacted with 8 per cent moisture of 108 lb. dry weight, when it becomes saturated. It is thus seen that this soil when properly compacted may require 24 times more pressure for penetration when saturated than will be required when it is compacted so dry as not to spring under the roller.

Experiments have determined that no measurable softening from satur tion occurs at depths greater than to 5 ft. below the surface of this so when compacted at the moisture conte at the peak of the compaction curve. Precise methods for determining th are available in connection with per colation and consolidation tests to b described in a subsequent article.

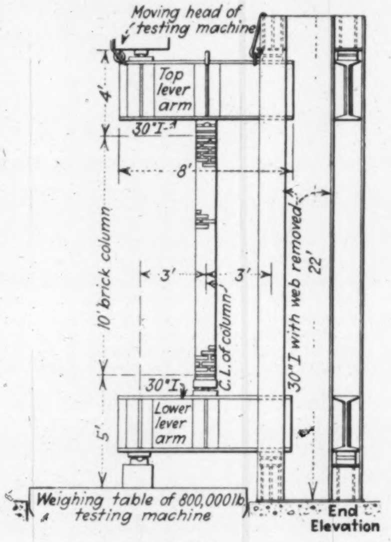
◆

Testing Machine Capacity Doubled by Special Loading Rig

By Inge Lyse

Research Assistant Professor of Engineering Materials, Lehigh University, Bethlehem, Pa.

During the last few years the Fritz engineering laboratory of Lehigh University has frequently been requested to test specimens that exceeded the capacity of its 800,000-lb. machine. To accommodate a recent investigation of reinforced brick columns (*ENR*, March 16, 1933, p. 345), a device was designed to double the compression capacity of this machine. This device consists of a lever system made up of two 30-in. girder beams and working on the "nut-cracker" principle, which is that of a second-class lever. A tension member holds one end of the levers at a fixed distance apart, while the movement of the head of the testing machine brings the other ends of the levers together. Since the test specimen is placed at the center of the levers (half way between the tension piece and the head of the testing machine), it is subjected to a load twice as great as the applied load.



Loading rig for doubling the capacity of an 800,000-lb. testing machine consists of a "nutcracker" made up of 30-in. girder beams. Placing the specimen half way between the load and the fulcrum of the lever subjects it to twice the applied load.

A sketch of the lever system is shown in the accompanying drawing. Roller bearings are provided in both directions at the top of the test columns and in one direction at the bottom. The tension member consists of the two flanges of a 30-in. girder beam from which the web has been cut. In order to give sufficient resistance to shearing stresses, the beam sections used as levers had to be reinforced with extra plates welded to the web.

In order to calibrate this loading rig, a 9-in. steel pipe with a ⅞-in. wall thickness was utilized as the test specimen, deformation readings being taken on four 50-in. gage lines by means of 1/10,000-in. Ames dials. The pipe was then placed directly in the 800,000-lb. machine and deformation readings taken. From the load-deformation curves for both methods of tests it was determined that the multiplication ratio between the load in the testing machine and that applied by the rig was 2.02 and that it was constant within the range of the calibration. The multiplication factor aimed at was 2.00.

By means of this loading rig the capacity of the machine has been increased to 1,600,000 lb. in compression. The cost of the rig was very low, as all construction work was done by the laboratory staff. The present set-up is convenient for the testing of sections 10 ft. long. By welding another support for the top lever at any desired height of the tension member, tests of shorter specimens may easily be made.

◆

Large Total of Construction Planned in Canada

Twenty-six cities in Canada expect shortly to undertake engineering and building projects amounting to $160,000,000, according to a survey made by the National Construction Council. Twelve local committees are to be appointed at strategic points in the Dominion, to be formed along similar lines to the National Construction Council, in order to cary out survey and research work in the various provinces for the national body.

In all, questionnaires were sent to 54 centers, and it is expected that the final figures will reach a total of $350,000,000.

Concrete Caissons Sunk by Air-Lift Pumping

Landing jetty at Le Verdon, France, with direct rail connection to Bordeaux, founded on 96 cylinder caissons sunk by the sand-ejection process

LE VERDON, the out-port of Bordeau, France, is being improved as a port-of-call to give more direct rail connection to Bordeaux some 60 miles farther up the river Garonne. This stream flows into the estuary Gironde at the entrance of which Le Verdon is located. An important part of this improvement is a deep-water landing jetty connected to the shore by a viaduct carrying a double track railway and a roadway. The general arrangement is shown by Fig. 1 redrawn from a map in *Le Genie Civil* to which we are also indebted for the information that follows.

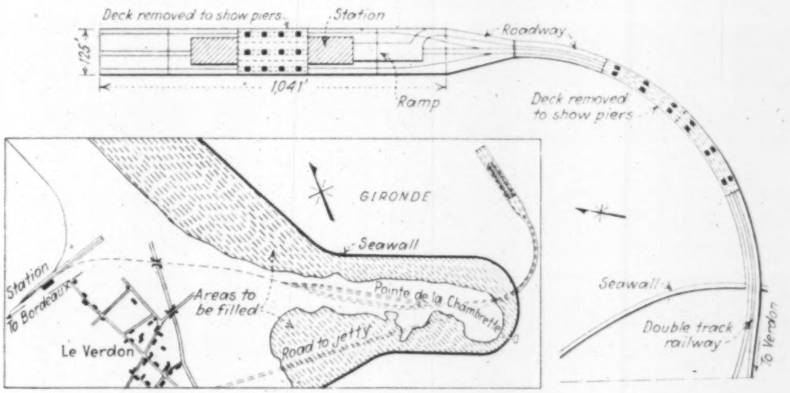
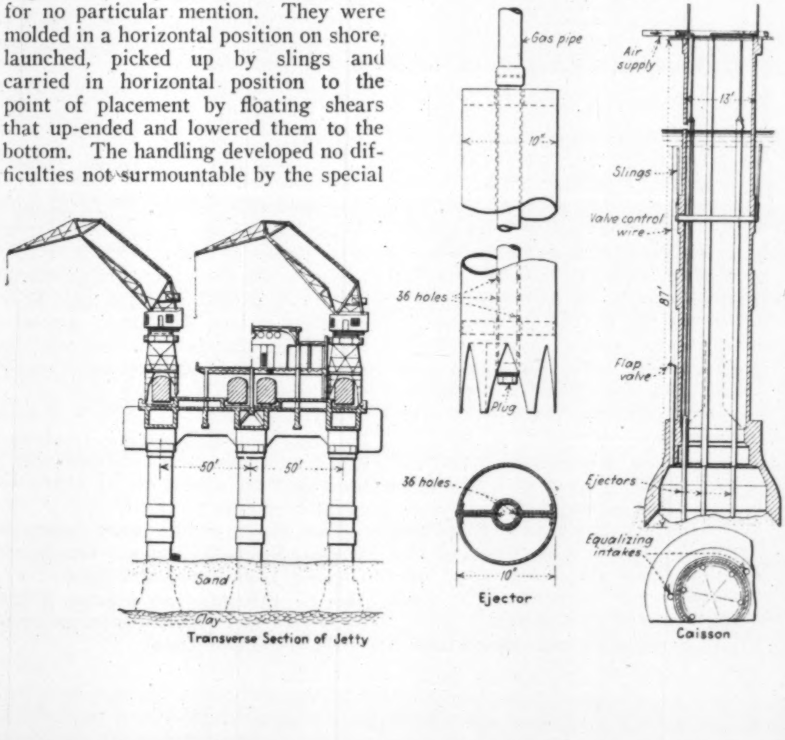


Fig. 1—Location map and large-scale plan of the deep-water landing jetty at Le Verdon, the out-port of Bordeaux, France.

As indicated by Fig. 1, the landing jetty and viaduct are reinforced-concrete girder decks carried on two- or three-cylinder bents of reinforced-concrete open caissons. A skeleton section of the landing jetty is shown by Fig. 2, which also shows one of the cylinder caissons and a detail of the ejector for evacuating the material excavated in sinking the caissons. A total of 96 of these caissons was sunk through water and a bed of sand, shells and pebbles into a firm gray clay. At the site of the work the sand bed is from 23 to 33 ft. deep, and the water is from 40 to 53 ft. deep.

The caisson details were changed somewhat as experience increased with the progress of construction, but the form finally adopted was that shown on Fig. 2. The cylinders themselves call for no particular mention. They were molded in a horizontal position on shore, launched, picked up by slings and carried in horizontal position to the point of placement by floating shears that up-ended and lowered them to the bottom. The handling developed no difficulties not surmountable by the special heavy equipment used; the caissons, weighing 290 metric tons, were handled by 300-ton capacity shears. The problem of suspending the up-ended caisson in true vertical position for lowering was solved by the device shown by Fig. 3; a telescoping axle is inserted in diametrically opposite holes in the caisson shell, and the outside protruding ends are caught by slings, as shown by Fig. 3.

Fig. 2—Section of landing jetty and details of supporting reinforced-concrete caissons and sinking equipment.



Transverse Section of Jetty

Ejector

Caisson

The distinctive feature of the caissons, as shown by Fig. 2, is the battery of ejectors suspended from a framework at the top at six equidistant points around the inside of the shell. Each ejector consists of a 10-in. pipe with a toothed bottom to penetrate the sand, inside of which is a gas pipe connected with compressed air. At the bottom the gas pipe is perforated with small holes from which the air escapes, churns up the sand into emulsion with the water and aerates the water in the ejector pipe, causing it to rise and flow out at an outlet above water level. To prevent blow-ins under the edges of the caisson, a valve-controlled inlet pipe (Fig. 2) permits the hydrostatic head in the caisson to be balanced with that of the water outside.

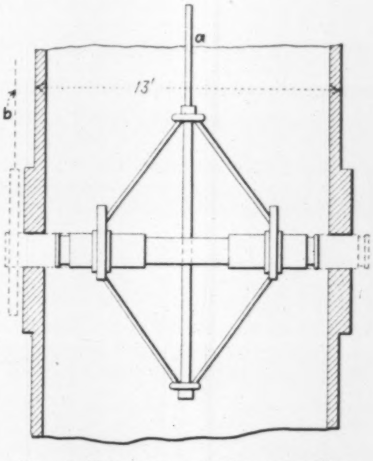


Fig. 3—Telescopic axle for suspending caisson while lowering it to position for sinking. Telescoping is actuated by screw *a* operated from top of caisson; slings are attached at *b*.

With the powerful shears the caisson could be very accurately located on the bottom. Verticality was established by a pendulum device set on top of the caisson. This device also enabled the operators of the ejectors to observe any inclination from plumb and to correct it by shutting off one or another of the ejectors; the limit of correction by this method was about 10 per cent. For larger readjustments and to keep it generally steady during sinking, the caisson was supported by a powerful crane. No considerable difficulty was experienced in keeping the caisson plumb.

The rate of sinking was remarkably fast. This was one of the reasons for adopting both the plan of precasting the caissons full height and of sinking them by ejection. In the exposed estuary it was important that working time in the open should be reduced to the least period possible. After the operations were well organized, caissons were regularly put down at a rate of 3 ft. an hour, and at times with twice this speed. Regularly the total time of handling and sinking a caisson came within nine hours; the actual sinking time was seven hours. With the caisson bottomed, a concrete seal was placed under water, and then the shell was pumped out and concreted in the dry. The remainder of the jetty structure was handled by usual concreting methods.

The port work, of which the landing jetty is a part, is under the direction of the Autonomous Port Authority of Bordeaux, with F. Lévêque as director and chief engineer. The jetty construction was carried out by the Société Anonyme Hersent.

Spring-Summer Operation at Lake Michigan Filter Plants

OPERATING RESULTS of six filtration plants on Lake Michigan north of Chicago during the spring months of April, May and June, indicate certain anomalous conditions. While the water is clearer the filter runs are longer. As the season advances microorganisms become more numerous, shortening filter runs. Further, the viscosity of the water gradually drops as the temperature rises, making desirable higher rates of filter-washing, although no Lake Michigan plants vary the rate as is done with favorable results at Cleveland. All these things result in shorter runs at the time when more capacity is required because of increased demand, and they necessitate various operating expedients to maintain satisfactory service conditions. Just what was done during this past season by the operators at Highland Park, Racine, Glencoe, Lake Forest, Waukegan and Kenilworth, Ill., was discussed at a meeting of the North Shore Water Producers Association.

Coagulant—Because of the low turbidity of Lake Michigan water, coagulant amounts vary but little in all of these plants, from 0.66 to 1.1 grains of aluminum sulphate per gallon. Alum is the only chemical used for coagulant.

Mixing — Time of mixing varies sharply, from 1 min. to 2.6 hours as follows: Highland Park, in April, 2.6 hours, May, 2.0, and June, 1.17 hours; Racine, 35 min.; Kenilworth, 6 min.; Lake Forest, 1 to 3 min.; Waukegan, 6 min.

Settling Time — The variation in settling time also varies, but not so much: Highland Park, 9.5, 7.5 and 4.2 hours for April, May and June, respectively; Racine, 6, 5 and 4.5 hours; Kenilworth, 1.5 hours; Glencoe, 3 hours nominal; Lake Forest, from 1 to 3 hours; Waukegan, 5.5 hours.

Filter Rates—Generally, filter rates were kept below the normal rating of 125 m.g.d. per acre, but during the excessively hot days in the latter part of June one of the plants exceeded this figure by 43 per cent.

Filter Runs — Data disclosed a remarkable variation in operating procedure and results, with the runs getting distressingly shorter toward the end of the period. Highland Park filter runs between washings were 30.5, 18 and 6 hours minimum for the three months. Operation in June involved "bumping," or shaking up by turning washwater into the underdrains for a few minutes to break up the schmutzdecke. Washing was for 5.3 to 5.8 min. at a rate of 29 in. per minute vertical rise.

Racine filters reversed the usual record: 27, 24.8 and 31.75 hours, the latter figure being due to "bumping" as many as five times in 9 hours, with an average of two per run. Washes varied from 3 to 11.75 min., averaging 6.75 min. at 21 in. per minute.

Kenilworth has a limited storage and of necessity cannot wash often. Once a day is the routine, but the operator has devised a traveling top-washing rake or grid which can be pulled over the surface in a minute's time and which rejuvenates the bed for several hours. This 1½-in. manifold pipe has ¼-in. pipe nozzles 4 in. long screwed into it on 4-in. centers. The ends of the nozzles are mashed to give a fan-shaped jet. The manifold travels on barn-door-hanger tracks with the nozzles penetrating the sand by several inches. Water under 50 lb. pressure is supplied through a hose. The effect on the effluent is not noticeable as to turbidity. Chlorination takes care of any increase in bacteria. Ordinarily the grid is used once in 8 hours. Washing for 5 to 7 min. is at the rate of 24 in. per minute.

Glencoe filter runs were 55 hours long in April, 23.5 hours in May and 10.5 hours in June, when each filter was "bumped" once between each wash. Washing was for 3 to 4½ min.

Lake Forest filter runs varied from 2 to 36 hours and were "bumped" o casionally, due to the times betwe washes in June. Washing was for min. at 26 in. per minute.

Waukegan runs averaged 11.95, 10 and 7.1 hours respectively for the thr months, but the filters at that plant o dinarily are run only 12 hours or unt the loss of head reaches 8 ft. Th minimum run was 1.5 hours. "Bumping is not practiced.

Taste and Odor Control—In the si plants, control of tastes and odors anything but standard. Excess chlorin activated carbon and aeration are a practiced, but in most of the plants som tastes and odors still persist at time

Highland Park applies chlorine to th raw water and then ammonium-sulphat This chemical is found more economica than anhydrous ammonia. Carbon als is applied to the raw water when taste and odors appear. This year it has been used continuously since May, as high a 100 lb. per million gallons on occasion.

Racine uses chlorine in the rates of 1 to 3 p.p.m., with the application divided between the raw and filtered water, about 0.2 p.p.m. being added to the latter. No carbon is used and no complaints are received except when hydrants are being flushed. Superchlorination alone is depended on to eliminate tastes and odors.

Kenilworth adds carbon to the raw water and is successful at most times in keeping down tastes and odors. However, in late June 75 lb. of carbon in 800,000 gal. of water failed to remove the tastes. The carbon is carried over to the filters but does not seem to penetrate the sand materially. Chlorine (8 lb. per m.g.) is used.

In Glencoe superchlorination is practiced, with the residual chlorine removed by sodium bisulphite. No carbon is used. During a few days of heavy pumpage, tastes and odors were observed in various parts of the distribution system. At times of maximum taste as much as 3.5 p.p.m. of chlorine was used, which gave a residual of 0.8 to 1.0 p.p.m. in the clear-water reservoir.

For Lake Forest 2 p.p.m. of prechlorination is used with 0.2 p.p.m. of postchlorination. From 18 to 60 lb. of carbon has been used, but still tastes and odors persist at times. This is ascribed in part to the short period of sedimentation (1 to 3 hours) and in part to insufficient carbon. Carbon is applied to the mixing chambers, carries over into the filters and often greatly reduces filter runs.

For Waukegan 2 to 2.5 lb. of chlorine per m.g. is used, leaving a residual of 0.12 p.p.m. No carbon or ammonia is used, and no complaints of tastes and odors have been received.

The above results were given for Highland Park, Racine, Kenilworth, Glencoe, Lake Forest and Waukegan by Messrs. Prindle, Peirce, Laye, Pflanz, McNichol and Domke, superintendents of the respective plants.

Power and Irrigation Work Financed by PWA

Casper-Alcova irrigation project and Seminoe storage reservoir and power plant to be built with funds provided by the Public Works Administration under the Recovery Act

TWO MAJOR PROJECTS for the development of the North Platte River Valley in Wyoming are covered by an allocation of $22,700,000 of federal funds, announced by the Public Works Administration Aug. 1: the Casper-Alcova irrigation project and the Seminoe power and storage project. The 66,000 acres to be irrigated under the Casper-Alcova project lie to the north and west of Casper and will be served by a canal leaving the river above a dam near Alcova, 10 miles below the dam of the Pathfinder Reservoir. The proposed Seminoe Reservoir will be located on the main river above the Pathfinder Reservoir.

Need for the additional water supply of 910,000 acre-ft. to be provided by the Seminoe Reservoir is generally conceded by those interested in the development of the North Platte Valley, but construction of the Casper-Alcova irrigation project is strongly opposed by the state of Colorado as being prejudicial to its rights to water originating in Colorado if built before the states of Colorado, Wyoming and Nebraska reach an agreement concerning allocation of the waters of the North Platte River.

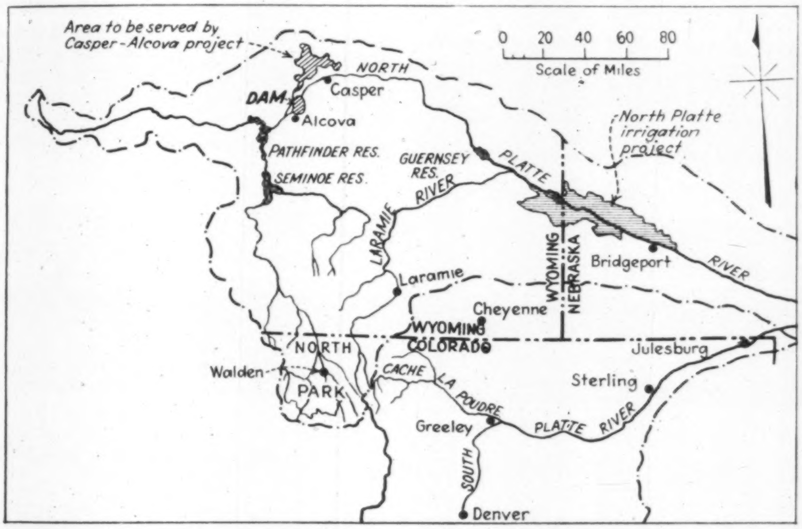

Area to be served by Casper-Alcova project
Scale of Miles
0 20 40 60 80
NORTH
Casper
DAM
Alcova
PATHFINDER RES.
SEMINOE RES.
GUERNSEY RES.
PLATTE
RIVER
LARAMIE
North Platte irrigation project
WYOMING
NEBRASKA
Bridgeport
RIVER
Laramie
Cheyenne
WYOMING
COLORADO
Julesburg
NORTH
PARK
Walden
CACHE
LA POUDRE
Sterling
Greeley
PLATTE
RIVER
SOUTH
Denver

Fig. 1—North Platte River Valley, showing the location of the proposed Casper-Alcova irrigation project and the site of the projected Seminoe Reservoir.

The money allocated to the two projects is divided as follows: $16,500,000 for the Casper-Alcova project, and $6,200,000 for the Seminoe Reservoir and power plant.

Casper-Alcova project

The Casper-Alcova project is located in Natrona County, Wyo. Casper, the second largest city in the state, is at the southeastern border of the main body of irrigable land. Except for Alcova, 32 miles southwest of Casper, there are no other towns within or near the project except railway stations.

The irrigable land begins at a point near Alcova and extends to the north in a comparatively narrow strip along both sides of the river. The area on the east side of the river is small, terminating near Bates Creek in a broken hilly country. On the west side the irrigable lands continue in a rather narrow body to Emigrant Gap Ridge, being broken by Bessemer Mountain some 5 miles south of the ridge, and by other scattering non-irrigable areas. North of the ridge the area widens out, reaching a maximum width of 23 miles at a point 6 miles north of Casper. The irrigable area extends 16 miles north of Emigrant Gap Ridge, and the project has a maximum length, north and south, of 37 miles. The area north of the ridge is fairly continuous topographically but is badly cut up by non-agricultural bodies.

Eighty-eight per cent of the land is privately owned, 8 per cent public land

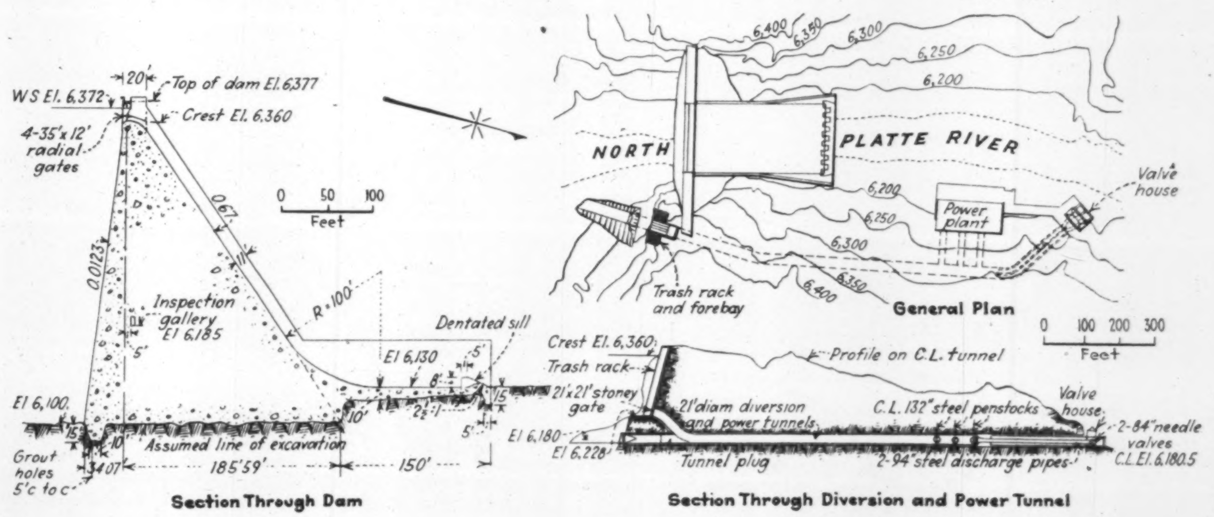

20'
Top of dam El. 6,377
W.S. El. 6,372
Crest El. 6,360
4-35'x 12' radial gates
0 50 100
Feet
0.67
1
0.0123
Inspection gallery El 6,185
5'
R=100'
Dentated sill
El 6,130
5'
8'
15
2½:1
10'
5'
El 6,100
15
10'
Assumed line of excavation
Grout holes 5'c to c
34'07'
185'59'
150'
Section Through Dam
6,400
6,350
6,300
6,250
6,200
NORTH
PLATTE RIVER
Valve house
6,200
6,250
Power plant
6,300
6,350
6,400
Trash rack and forebay
General Plan
0 100 200 300
Feet
Crest El. 6,360
Trash rack
21'x21' stoney gate
Profile on C.L. tunnel
21' diam diversion and power tunnels
C.L. 132" steel penstocks
Valve house
2-84" needle valves
El 6,180
El 6,228
Tunnel plug
2-94" steel discharge pipes
C.L. El. 6,180.5
Section Through Diversion and Power Tunnel

Fig. 2—The dam for the Seminoe Reservoir is to be a concrete gravity-type structure. The power plant will be supplied with water through the diversion tunnel in the canyon wall.

and 4 per cent state land. It lies in the center of extensive range country where the present irrigation development is too limited to supply stock men with winter feed and to furnish Casper and nearby oil fields with required foodstuffs.

The report of the U. S. Bureau of Reclamation to Congress on the project states that its construction will fill a great community need and would be of particular benefit to the city of Casper and to local range and livestock interests. It states further, however, that construction costs are expected to be so high as to require annual assessments two or three times as large as the land can be expected to pay if repayment is expected in 40 years, the limit of time under the present reclamation law. For this reason the bureau suggests that part of the difference might well be met by the city of Casper, since it will benefit most by the construction of the project.

Alcova dam and canal

The proposed diversion dam is to be located at the lower end of the Alcova Canyon, about 32 miles above Casper. It will deliver water to the main irrigation canal at El. 5,500, or 169 ft. above the present river level.

Both a concrete gravity type dam and an earth and rockfill dam were considered by the Bureau of Reclamation in its studies, but the latter was recommended in its report, chiefly because of lower construction cost. The dam will have a maximum height of 235 ft. above the base of the cutoff wall and 181 ft. above the riverbed.

The main canal, lying west and north of the river, is to have an initial capacity of 1,130 sec.-ft. and will terminate six miles north of Casper. Its total length is to be 106 miles. Two laterals, which cross the North Platte River in siphons, will supply water to the irrigable land on the east side of the river. Land north of Casper not reached by gravity flow is to be supplied by pumping.

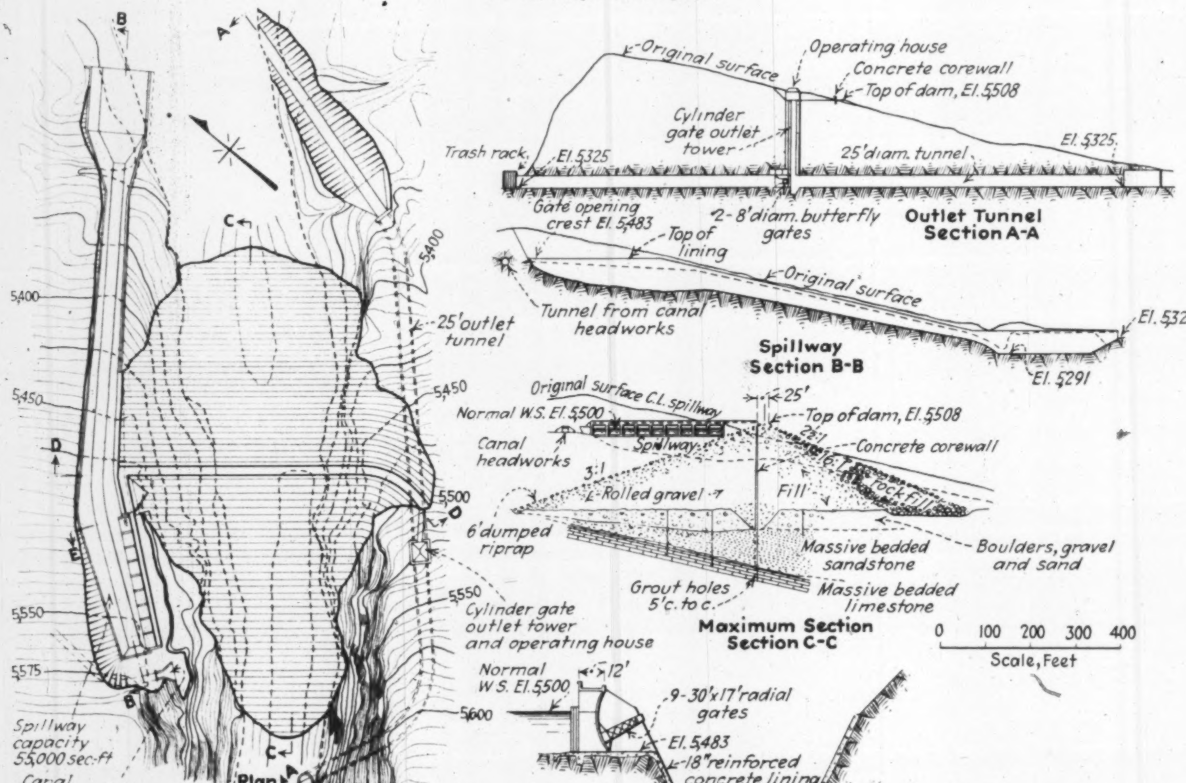
There are to be 32 miles of main lateral canal and a storage reservoir of 3,000-acre-ft. capacity on the easterly side of the irrigable area.

The Bureau of Reclamation's cost estimate as prepared in 1930 put the total cost of the project at $15,851,000, with the principal items $3,340,000 for the dam, $6,750,000 for the main canal, $760,000 for the main laterals, $1,320,000 for the lesser lateral system and $1,980,000 for drainage. Because of the change in wage and labor conditions under which the work now is expected to be carried out, the cost estimate was raised to $16,500,000 in the allocation of Recovery Act funds.

Seminoe Reservoir

The dam for the Seminoe Reservoir is to be located in Granite Canyon where the North Platte River runs between the Seminoe Mountains and Bennett Mountains, about 33 miles northeast of Rawlins, Wyo., a short distance above the upper end of the Pathfinder Reservoir. Studies of the site by the Bureau of Reclamation indicate that a dam raising the low-water level of the river 185 ft. to El. 6,350 and creating a reservoir with a capacity of 910,000 acre-ft. is best adapted to the site. The dam site lies in a narrow gorge, one abutment being of granite entirely exposed, and the other partly so. Explorations with diamond drills indicate a good bottom for the gravity-type concrete dam proposed by the bureau. The bureau proposes to drive a 21-ft. diversion tunnel through the canyon wall for construction purposes, and subsequently to use

Fig. 3—Plan and cross-section of the dam proposed to be built in the Alcova Canyon for the Casper-Alcova project.


B
A
C
5,400
5,450
5,500
5,550
5,575
5,600
D
E
B
C
25' outlet tunnel
Cylinder gate outlet tower and operating house
Spillway capacity 55,000 sec.-ft
Canal headworks
Plan
Top of dam, El. 5,508
Sandstone surface
Spillway
River bed
Outlet tunnel
Section D-D
Original surface
Operating house
Concrete corewall
Top of dam, El. 5,508
Cylinder gate outlet tower
Trash rack
El. 5,325
25' diam. tunnel
El. 5,325
Gate opening crest El. 5,483
2 - 8' diam. butterfly gates
Outlet Tunnel Section A-A
Top of lining
Original surface
Tunnel from canal headworks
El. 5,325
El. 5,291
Spillway Section B-B
Original surface C.L. spillway
25'
Normal W.S. El. 5,500
Top of dam, El. 5,508
Canal headworks
Spillway
2½:1
Concrete corewall
1.6:1
Rockfill
3:1
Rolled gravel
Fill
6' dumped riprap
Massive bedded sandstone
Boulders, gravel and sand
Grout holes 5' c. to c.
Massive bedded limestone
Maximum Section Section C-C
0 100 200 300 400
Scale, Feet
Normal W.S. El. 5,500
12'
9-30'x17' radial gates
El. 5,483
18" reinforced concrete lining
1:1
1:1
25'
Spillway Section E-E
0 25 50 75 100
Scale, Feet

the tunnel for the penstock line to the power house.

Studies of the power market indicate that the plant should have an installed capacity of 38,400 kw.

The cost of the dam is estimated at $3,750,000, the power plant at $2,280,000, and right-of-way, etc., at $130,000. The allocation of Recovery Act funds is $6,200,000.

Reservoir operation

The Bureau of Reclamation report states that Pathfinder Reservoir, the high-water line of which is but a few miles below the Seminoe Reservoir site, must be operated to meet the immediate irrigation demands. It has a capacity of 1,070,000 acre-ft. Storage is ordinarily withdrawn from July 1 to Sept. 30 each year. The Seminoe Reservoir, the bureau states, can be operated for power purposes, with its outflow redistributed by the Pathfinder Reservoir to fit the irrigation needs. Both reservoirs would fill in years of large runoff and be depleted in periods of scarce streamflow, their full capacity, excepting only dead storage set aside for power head, being available to meet irrigation needs. In the bureau's study 60,000 acre-ft. of the Seminoe Reservoir capacity was set aside to maintain a minimum power head of 93 ft. The remaining 850,000 acre-ft. would regulate the stream to produce a uniform power output of 18,100 kw.

Assuming the power market at Casper, Green River and Cheyenne, the average cost per kilowatt-hour of delivered power is estimated at 4.2 mills.

Start of construction

Extensive studies of the geology of the site of both dams have been made, and preliminary drawings for the dams and other structures have been prepared. Consequently the Bureau of Reclamation should be able to have contract drawings ready for bidding by late fall, thus permitting contractors to get their plant in during the winter when the ground is frozen. Work on the main canal of the Alcova project could be started almost immediately.

Interstate problems

As indicated in Fig. 1, the North Platte River rises in the North Park section of Colorado, flows north and east through Wyoming and into Nebraska. Hence, control of the flow of the river is an interstate matter and, as the low flow already is becoming inadequate to meet irrigation demands, attempts have been made to set up an interstate agreement providing for the allocation of water. So far no agreement has been reached.

Colorado has raised strong objection to the construction of the Alcova project because construction of that project before an interstate agreement is concluded would automatically give Wyoming a prior claim to the amount of water required for that project. Colorado estimates that 600,000 acre-ft. of water of the river originates within the state border, and it seeks definite allocation of 180,000 acre-ft. to its own uses, 100,000 acre-ft. of which it proposes to divert across the Continental Divide to the headwaters of the Cache La Poudre River in order to serve future irrigation developments planned for that valley in Colorado.

◆

Single Reading Glass Used to Produce Stereoscopic Effect in Photos

By T. A. Hayden

Assistant Engineer,
Salt River Valley Water Users' Association,
Phoenix, Ariz.

SINCE the development of low-priced convenient-sized cameras, their use in taking construction pictures has grown to a considerable extent. The superiority of such photographs over the ordinary type is so marked that a 2-in. picture viewed through the stereoscope exhibits details to a far greater extent than the best 8x10-in. picture taken with a high-class lens.

The writer has often observed that a decided stereoscopic effect is produced by viewing a photograph through an ordinary 5-in. reading glass. This is especially noticeable in pictures showing construction where complicated lattice work is shown, such as bridge trusses, reinforcement in place, concrete chutes, formwork or groups of men at varying distances from the point of observation. The perspective in such pictures is usually such that the various construction members or objects in the picture appear to be more or less in the same plane instead of in their true relation as to distance from the camera. The characteristic effect of the nearer objects standing out from those more remote is obtained to a striking extent by the use of a lens, as mentioned. The value of a picture is enhanced many times in this way, and it is possible to get an accurate conception of the scene displayed, which might otherwise be quite meaningless. It is conceivable that this property may be of considerable value where a photograph constitutes the principal evidence of the relative positions of several objects. The perspective obtained by use of a lens eliminates a large proportion of the element of doubt that exists without it.

The explanation of this fact or phenomenon was for a long time beyond the writer's ability to fathom, although it had been discovered many times with other engineers, as well as with opticians engaged in the manufacture of lenses. A recent appeal to Dr. I. C. Gardner, of the U. S. Bureau of Standards, brought the following comments:

"It is often true that the appearance of relief afforded by a photograph is improved by viewing it through a lens. A photograph is a projection on a plane and, if it is to appear in true perspective, it is necessary that it be viewed from the center of projection. For the present purpose it is sufficient to assume that the center of projection is on the axis of the lens midway between the two outer surfaces at the time the exposure is made, although, strictly speaking, it is at the second principal point. To appear in true perspective, the picture should be viewed from a distance equal to the focal length of the lens of the camera. With the use of a reading lens the photograph is viewed from the correct distance for true perspective, or from a less distance, in which case the depth effect is exaggerated.

"The use of a lens further helps by obliging one to view the picture with one eye. When a three-dimensional object is viewed with both eyes, the images received by the two eyes do not differ in the correct manner to simulate depth. Consequently a photograph or painting, viewed with both eyes, represents three-dimensional objects incompletely. Artists, to test the perspective of a picture, often view it with one eye. The center of projection of a painting or etching is usually at a distance sufficient to permit it to be viewed comfortably in correct perspective without a lens. Consequently, if it is in correct perspective, closing one eye will cause it to stand out in relief. On the other hand, if the perspective is faulty, examination with one eye quickly betrays it.

"The effect noticed is even more evident with smaller photographs than with 8x10-in. photographs. A 2¼x3¼ camera often has a lens of 3-in. focus. Consequently, when the photograph is viewed with the unaided eye at a distance of 10 in., the perspective is so poor that all impression of relief is destroyed. If the picture is viewed from a distance of 3 in. with a magnifying lens, the perspective is improved to an astonishing extent."

◆

Harnessing the Danube

The governments of Rumania and Yugoslavia are planning joint action in the erection of an immense hydro-electric plant and canals at Orsova, on the international boundary. About 750,000 hp. can be developed there at a cost of about £7,000,000. Electrification of railroads and intensification of industry in both countries is the goal, with improved shipping facilities on the Danube.

Ten Business Problems of Contracting

IV—Buying to Insure Greatest Profit

Profit is determined by costs in the structure and not prices at the factory—Character of market, available capital, facilities of producers, concentration of purchases are elements of problem

By J. L. Harrison
Senior Highway Engineer, Bureau of Public Roads, Washington, D. C.

IN MOST of the more important construction fields, contracting involves the purchase of large amounts of material that must be incorporated in the finished work. On this account the profit that can be obtained from contracting depends quite as much on correct buying as it does on correct selling. The margin in construction work seldom is wide. Usually it is small. Occasionally there is no margin at all. The necessary conclusion is that unless all buying is carefully handled such margin as there is will be lost.

Market conditions

In any general survey of the business aspects of buying the first matter to be considered is the position of the market from which materials must be secured. At any particular time the commodity markets in general are either strong, steady or weak—that is, prices show a distinct tendency to rise, are holding about on a level or are falling. It is equally true that the market for specific kinds of materials, such as building materials, may occupy a different position from the general commodity market, as well as a different position from other specific kinds of commodities. In the recent past, for instance, the market for building materials generally has been only a little better than weak, the general commodity market steady to strong, while food stuffs and textiles have ruled strong—that is, prices definitely rising. Finally, specific commodities often show a trend that is distinctly out of harmony with the general trend of the group to which they belong. In the building-materials field the price of cement has for some time ruled strong in a market which, for other building materials, has been relatively weak.

Weak markets are often known as buyers' markets. Similarly, strong markets are known as sellers' markets. These terms have a great deal of business significance, for they allude to the fact that when markets are strong the sellers are able to dominate prices and therefore to force prices up, while weak prices enable the buyers to dominate the situation and force them down. It naturally follows that the trend of the materials markets has a distinct influence on price levels in the contracting field. But these trends also affect basic buying policies.

When the materials market is strong, prices usually are protected by securing firm quotations before bids are entered. On the other hand, when the materials market is weak, it is customary to enter into no agreement as to the prices to be paid for materials until business is in hand. The reasons are obvious. When prices are rising, any delay in making purchases is more likely to result in higher prices than in lower prices. When prices are falling, a similar delay in purchasing is more likely to result in lower prices than in higher prices.

These practices are based, then, on sound business judgment, but if this judgment is to be as accurate as is desirable it must rest on a broader knowledge of business conditions than can ordinarily be obtained from information which a contractor can himself collect. This suggests frequent reference to the information on prices and price trends regularly published by *Engineering News-Record* and other reliable business magazines. In the price field there may be some difference between the national price trends and regional or local price trends, but as a rule such differences are not very great. National statistics as to price trends are then a useful guide in determining the situation at any moment prevailing in the materials market, even though the local price level is quite different from the general price level on which the national trend is based.

After determining when to buy, the problem of where to buy must receive attention. Obviously the objective is the lowest over-all cost. But while this objective is easily stated, it is not as easily attained, for, beside the obvious tangible costs involved in purchasing materials, a good many intangible costs may also be involved.

Tangible cost naturally includes the price paid for materials and the cost of delivering them to the site of the work—that is, the cost of material f.o.b. job. In buying materials the usual practice is to obtain quotations from producers or from dealers. These quotations include a statement of the terms of payment as 30 days net, 2 per cent off for cash within ten days, sixty days' trade acceptance. The terms offered differ from place to place. They also differ as between the various kinds of material used. In the materials field, taken as a whole, bills are very commonly net if paid within 60 to 90 days, and not infrequently even more extended credit is given. Usually there is some discount for cash that is for payment within a more limited period. Freight usually must be paid by the consignee on the delivery of the materials. However, in a good many cases arrangements provide for payment by the consignor.

Working capital

Whether prices and terms are accepted as initially quoted, as they are likely to be in a sellers' market, or are used as the basis for further negotiation, as they should be in a buyers' market, there are various aspects of purchasing that must be considered before commitments are made. Of these, the available working capital is the first. If this is ample, net prices (that is, quoted prices less discounts) become the matter of first consideration. On the other hand, if working capital is so limited that discounts cannot be taken, the terms offered become the matter of primary importance.

There appears to be a general impression that the whole difference between the cash price for materials and the price 60 to 90 days net is the rather limited discount openly quoted on cash payments. Occasionally the difference is as little as this, but more generally the prices quoted to buyers who regularly pay cash include special discounts which place these buyers in a more favorable position than the nominal discounts regularly quoted to all buyers would indicate. But without regard to whether only openly quoted discounts or larger and more or less secretly quoted discounts are involved, the profit to be obtained by taking cash discounts is considerable if collections can be made promptly. As construction work is now handled, materials are incorporated in the work about as fast as they are delivered to a job. This being the case, most of those delivered during a given month should be included in the estimate for that month, any carryover being included in the estimate for the succeeding month. Payment should be received from ten to thirty days after the end of the month.

On this basis, the money used in meeting materials bills can be, and indeed should be, turned over from six to twelve times every year. Where this rate of turnover can be maintained—and if the business aspects of contracting are given proper attention, it can be—the working capital used in handling materials transactions should earn not less than 10 per cent a year, and under favorable conditions may earn two or three times this amount. Here the contractor who is in a position to take cash discounts has a distinct advantage over the contractor whose working capital is so limited that he must buy under terms permitting considerable delay in paying for materials.

Effect of freight charges

Freight charges are not subject to discount. On this account, when local materials are available at the same delivered price offered on those subject to a long freight haul, the local materials are apt to be the cheaper because discounts then apply to a much larger percentage of the delivered cost.

The contractor whose working capital is inadequate is forced to consider the procurement of materials from the standpoint of the effect the terms offered will have on his working capital. This working capital must be conserved at any cost, for payrolls and various other expenses, in particular freight charges, require cash. The retent tends to tie up such working capital as the contractor may have. If collections are slow, his situation is bound to be complicated further. Some specifications permit the inclusion of delivered but unused materials in the monthly estimate. When this is permitted, estimates based on material deliveries can be used, and frequently are used, to bolster up an otherwise-too-limited working capital.

Having determined the effect of all of these and any other conditions likely to have a bearing on the amount of working capital that will be available at critical intervals during the life of the job, in the light of the rate at which construction will proceed, it is possible to determine whether 60-day or 90-day or even longer credit on materials is required. This should not be a matter of guesswork or of accepting the longest terms offered. It should be a businesslike investigation of the conditions which there is reason to believe may be accepted, and the results of this investigation should be made available to those from whom materials are to be secured. Prices based on a complete knowlege of the conditions a contractor expects to face on a specific job are likely to be somewhat better than those offered to contractors who merely ask for and accept the longest terms that they can get, without regard to whether or not job conditions and the available working capital make such terms necessary. In particular, this is true for those contractors who are careful to maintain a reputation for meeting their agreements promptly; where this is done, the cost of extending credit does not greatly exceed the cost of borrowing the funds required in order to support this credit.

For contractors who are operating with an inadequate working capital and are doing so with a proper appreciation of the position that they therefore occupy, the available sources of supply are limited to those dealers and producers who offer terms that it is possible to meet, after which price and other considerations enter to govern the selection of specific sources. Too much emphasis can hardly be laid on this view of the purchasing problem. The contractor whose capital is inadequate should never ignore this fact either in planning his operations or in dealing with business associates. If the fact is recognized and due allowance made for it, his situation, though not as favorable as that of his better-financed competitors, is by no means hopeless. But if this fact is ignored or overlooked when purchasing agreements are made, serious financial difficulties often arise.

In all purchasing the objective is, of course, the best possible price. But this may not be the lowest price f.o.b. job. A good many things beside prices and terms must also be considered. One of these is the financial position of the seller. To the contractor who is buying on a cash basis this is important, particularly in a rising market—for any disturbance of materials deliveries is expensive. It is even more important to the contractor who is buying on a 60- to 90-day basis. In the event a producer or a dealer gets into financial difficulties, cash business can be transferred without difficulty and usually without much loss. Business requiring extended credit cannot be as easily transferred. The contractor who buys for cash has another advantage here. Cash busines tends to strengthen the position of the seller. Credit business tends to weaken his position. Those who require extended credit should endeavor to obtain it from strong concerns. Weak concerns should be definitely avoided.

Any interruption of construction is expensive. There is no need to discuss the reason here. The fact is recognized by all who are familiar with construction work. But this fact has a broader significance than a mere reference to construction cost implies, for while the effect of delays is to increase construction cost, a considerable part of these delays originate in the selection of the sources of supply, so that their avoidance depends on an avoidance of unreliable sources.

In prosperous times a fruitful cause of delay is the all-too-common practice of selling in excess of production capacity. Producers are not solely to blame. Buyers often duplicate orders. Both practices are indefensible, but neither can be wholly corrected without the cooperation in this matter of both buyers and sellers. However, so long as producers occasionally do oversell their capacity it will be necessary for those in charge of purchasing to give attention to this as a possibility, and so to avoid the slow deliveries that result by placing orders with dealers and producers who are not overcommitted.

In a buyers' market prices are often forced so low that every delivery involves a loss. While prices remain low, this does not, as a rule, cause any difficulty unless the producer is forced into bankruptcy. But when prices begin to rise, orders taken at a loss are apt to receive less attention than is given to those taken at a profit. Considerable difficulty in maintaining construction schedules has occasionally resulted. As all indications at the moment point toward rising materials prices, this matter should be given some consideration in connection with orders placed during the next few months and perhaps for a longer period.

Producer's facilities

Materials are pretty uniformly purchased under definite specifications as to quality and as to any other considerations that affect their use. Therefore it is necessary to give some attention to the facilities that a producer has at his disposal and to consider whether these warrant a conclusion that specifications can be and will be regularly met. It is particularly necessary to do this if the specifications for the job in hand differ in any important respect from those usually considered standard. As a rule, producers are equipped to supply materials that meet the ordinarily accepted specifications. Non-standard specifications may involve no change in the established processes and practices that govern production, but, on the other hand, rather considerable changes may be required. As an illustration, if for some reason the specifications call for cement that is 10 per cent stronger than standard requirements, mills not regularly providing cement of this strength would usually find it quite difficult to supply. Mills regularly producing cement of this sort are, therefore, the logical sources of supply. The same is largely true of other building materials. Special specifications tend to limit the sources of supply.

A somewhat similar problem is faced in deciding whether or not to deal with small producers—a problem that may arise in purchasing almost any material except cement and steel but one that is most frequently encountered in purchasing such materials as lumber, sand, gravel and broken stone. Beyond a doubt it is as fully the intention of small producers to meet the specifications under which sales are made as it is of large producers. But the small producer faces a difficult problem in handling other than small orders. This situation arises from the fact that in working out the basic sources of supply — as, for example, a gravel pit—the quality of the material encountered is likely to vary a good deal from day to day. To work at a profit, the producer must make use of as much of the material handled as possible. This the large producer can do readily enough, for his larger market will absorb a large variety of materials. The small producer is handicapped because materials he cannot use in filling a large order are likely to become waste. As an entirely natural result, the material supplied on a large order is likely to be less closely controlled than if it is furnished by a large producer, with the result that rejections tend to be of somewhat more frequent occurrence. This statement is not intended to imply that materials ought never to be obtained from small producers, for this is not the case. Rather the thought is that when materials are offered by small producers, more than the usual precautions should be taken to ascertain that materials complying with the prevailing specifications can be and will be regularly supplied.

There are, of course, other matters that also deserve attention when the selection of sources of supply are under consideration, but enough have been mentioned to draw attention to the fact that price is not the only matter to be considered in purchasing materials. The objective is the lowest cost incorporated in the work, and while the cost f.o.b. job is a major factor in this cost, it is likely not to prove the only cost to be considered unless the certainty and the quality of the deliveries are given pretty careful attention before buying orders are placed.

Rejections and slow delivery of orders tend to disrupt construction schedules. The lack of a single material may entirely stop operations. Any disruption of the construction program, any delay and every closing down of operations involves unavoidable expense. Some men are paid straight time, so delays mean the loss of time for which the contractor is paying. Rentals on expensive equipment continue whether any work is done or not. The men become more or less disorganized if there are many delays. There are other things that generate expense—often in rather important amounts. If the materials supply is to be eliminated as the cause of expense of this nature, it can be done only by exercising a good deal of care in placing orders.

Concentration of purchases

Occasionally some question arises as to whether orders ought to be distributed among a number of producers or concentrated as much as possible. The writer believes in the greatest possible concentration of orders. As a rule, large producers are more reliable sources of supply than small producers. Usually they are better financed and better organized. As a class they understand better both the ordinary and the unusual problems that a contractor faces, for they have had a broader experience in dealing with the supply problem.

In concentrating orders and in placing them with large producers the contractor has the further advantage of dealing with a relatively small number of concerns, so that he comes to understand their business methods and they to understand his to his advantage as well as theirs. Those who advocate scattering orders often base their position on the theory that this invites keener competition. In a falling market there is something to be said for this point of view but, even then, there is more of an appearance of benefit than any actuality. The contractor who sticks to a well-selected group of strong producers will usually find that they are quite as active in protecting his interests as their competitors can be. In the ordinary relationships that business transactions involve, there always is a good deal of friendly cooperation, not only in getting business and in holding it but in the little things that help to make it profitable. The reliable contractor who has established his standing with a limited group of strong producers through years of attachment to them as a steady customer usually has no reason to regret this course and often has much reason to appreciate the definite assistance that such attachments have enabled him to secure when assistance was badly needed.

Modern construction practices usually involve the use of materials about as fast as they are delivered. The contractor's interests are best served if deliveries and use are kept in exact harmony. In practice the perfection that the contractor would prefer cannot be attained. The contractor's construction organization may be excellent, but it is not likely to be perfect, so his own schedule is not likely to be carried out exactly. On some types of work the weather is likely to cause interruptions. Deliveries by freight are well handled, but they are not perfect. The producer, too, is unlikely to be in a position to guarantee exact compliance with any schedule of deliveries.

The accepted method of construction requires that a schedule of shipments be made a part of every material contract of any size. The terms of this contract should also provide for halting shipments and changing rates of delivery within reasonable limits. But, as the producer usually depends quite as much on being able to make regular shipments as the contractor does on receiving his materials regularly, and as the producer's operations are quite as adversely affected by interruptions as are the contractor's, the interests of both parties to a materials contract are best served if the contractor agrees to provide reasonable facilities for storing materials and to interrupt the shipping schedule only in the event that his storage is exhausted. This protects the producer against all but the more important delays that field operations involve, and in the long run it generates prices that are more favorable than could be expected if all the delays occurring on a field job were passed back to the producer.

Off-season buying

From time to time efforts are made to stimulate the off-season sale of materials for immediate delivery and storage. Little need be said in regard to this matter, except that off-season buying has never proved popular and is not likely to be more so in the future. There are several reasons for this. In the first place, off-season buying ties up working capital and sharply reduces the rate of turnover on whatever capital is used for this purpose. In the materials field the margins of profit are not large, and there are no other conditions incident to materials production that make it possible to grant discounts on off-season purchases that are large enough to make such purchases particularly attractive. But even if the discounts offered were attractive, the fact would still remain that, as a group, contractors do not have enough working capital to warrant the use of much of it in this way. Indeed, from the business standpoint, the general inadequacy of working capital is the most conspicuous weakness of construction organizations. This situation should not be aggravated by off-season buying.

But if working capital were available in such amount as apparently to warrant off-season buying, it still would not ordinarily be practical. Rehandling costs are too heavy. Loss and damage in storage must be considered. There also is some danger of loss through pilfering, even though a watchman is employed to guard the materials placed in storage.

In short, the conditions under which materials are sold and the practices that govern construction, as well as the very general inadequacy of the working capital that contractors have available for financing their ordinary operations, all tend to prevent much off-season buying. Under conditions as they stand today, the practice cannot be recommended.

New Bridge to Be Built in British Columbia

An agreement has definitely been entered into between the Ladner Bridge Co. and the province of British Columbia, looking to the construction of a high-level highway and pedestrian bridge over the Fraser River near Deas Island. The agreement provides that the company make a start within six months and complete the structure within two years on plans approved by the dominion and province respectively. The probable cost of the bridge will be around $1,750,000.

Reinforced-Brick Walls Reduce Steelwork

Walls require functional properties not satisfied by prefabricated wall sheets—Same economy provided by reinforced brick, which meets all functional requirements

By L. B. Lent
Wilber Watson and Associates, Cleveland, Ohio

Those who think of reducing building costs by the use of prefabricated walls or wall sections often forget two important considerations: (1) Outer walls must meet certain functional or service requirements; and (2) their cost represents only a fraction of the total cost of any building.

Wall costs of industrial buildings are usually not more than 15 per cent of the total; and for commercial (office) buildings wall costs are more often a smaller item unless expensive cut-stone covering is used. Hence, reducing outer-wall costs by as much as 50 per cent would reduce the total cost only 7½ per cent. But such a large reduction is highly improbable if all service requirements are to be met.

These essential service requirements are: strength (compressive, flexual and shearing), fire-resistivity, weather resistance and durability. Resistance to heat and sound transmission are important secondary requirements. Pleasing appearance is often a prime consideration.

Functions analyzed

Strength in masonry panel walls stiffens the frame against distortion. Informed designers take advantage of this knowledge to reduce the size, and hence the cost, of the framing members. In panel walls the designer must allow for a strength that will be sufficient to resist wind (and sometimes earthquake) force.

Fire-resistivity is a prime requisite. The outer walls of a fully protected or "fireproof" building must develop a resistance period of not less than four hours, according to most building codes. Not all wall types can meet such a requirement. Solid masonry walls not more than 8 in. thick will do so, but certain metals and alloys (frequently mentioned as rational materials for wall "shells") will not. In fact, most thin metal sections would fail to develop a four-hour resistance period.

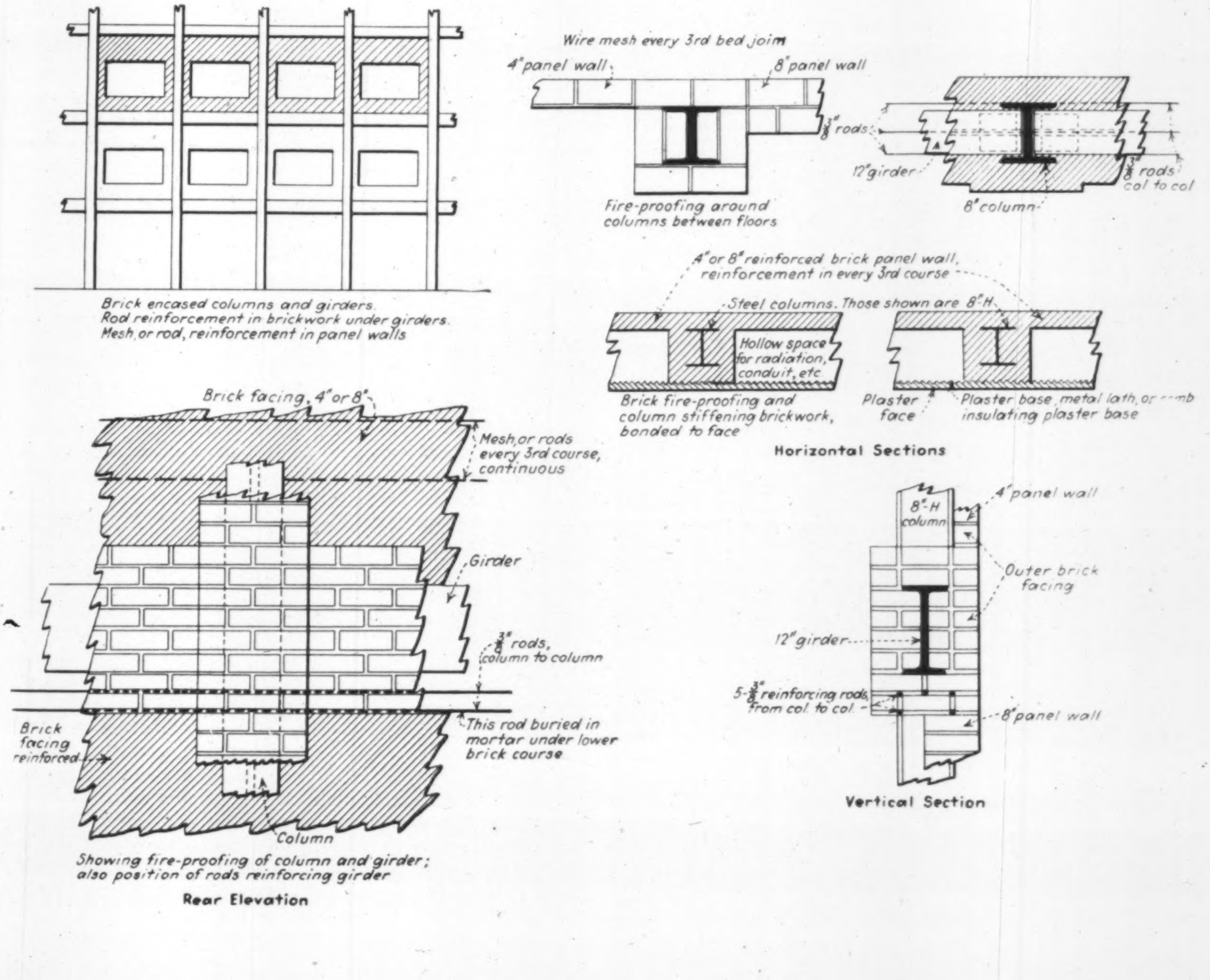
Durability is desirable despite some ideas about obsolescence. The investment should be protected for a reasonable number of years. Cheap walls may also be durable, but this is not the general rule.

There is no single material that meets all service requirements in the highest degree, whether it be stone, brick, concrete, steel, aluminum or whatnot. Each may possess superiority in one or more respects, but not in all.

Combination of materials best

Obviously, outer walls may be built of a single material, or of some combination of materials. Some combination would seem to meet all service requirements best. A judicious choice might result in lowest cost. For example, a wall section might consist of

Fig. 1—Details of proposed reinforced-brick wall construction for steel-frame buildings.



Brick encased columns and girders.
Rod reinforcement in brickwork under girders.
Mesh, or rod, reinforcement in panel walls

Showing fire-proofing of column and girder; also position of rods reinforcing girder

Rear Elevation

Horizontal Sections

Vertical Section

Wire mesh every 3rd bed joint
4" panel wall
8" panel wall
3/8" rods
12" girder
3/8" rods col to col
8" column
Fire-proofing around columns between floors
4" or 8" reinforced brick panel wall, reinforcement in every 3rd course
Steel columns. Those shown are 8"-H
Hollow space for radiation, conduit, etc
Brick fire-proofing and column stiffening brickwork, bonded to face
Plaster face
Plaster base, metal lath, or
insulating plaster base
Brick facing, 4" or 8"
Mesh, or rods every 3rd course, continuous
Girder
3/8" rods, column to column
This rod buried in mortar under lower brick course
Brick facing reinforced
Column
8"-H column
4" panel wall
Outer brick facing
12" girder
5-3/8" reinforcing rods, from col. to col.
8" panel wall

an outer shell that would be fire-resistive, watertight and durable against the severest attack of the elements, adding real strength to the structure and withal possessing beauty; an inner mass or filling that would be resistant to heat transmission and perhaps contribute to the strength; and an inner covering that would form a pleasing decorative surface.

Such combination wall sections are, as a matter of fact, the ones more often used. Brick or stone facing is backed up by other brick, tile or concrete; and an inner finish of lath and plaster completes the wall section, either as a bearing wall or as a filler wall in framed buildings.

Possible steel economy

If we were to apply some recently acquired knowledge, it would seem possible to reduce both framing costs and wall costs and still fully meet service requirements.

Recent tests at the Bureau of Standards have shown that slender steel columns incased in masonry (brickwork in these tests) can be counted on to carry compressive loads up to the yield point of the steel before failure occurs. To be specific, columns 24 ft. long with an l/r of 163, incased in brickwork, failed at about 40,000 lb. per sq.in., whereas steel columns tested bare failed at about 22,000 lb. per sq.in. Coupons 8 in. long cut from these columns also failed at about 40,000 lb. It would therefore appear that our column formulas can be revised. Tests of columns incased in concrete confirm this conclusion.

Again, information recently acquired indicates that steel spandrel beams may also be safely reduced in size if designed to function in combination with a reinforced-concrete or reinforced-brickwork beam. Since steel spandrels have to be fireproofed with brick or concrete, why not incorporate reinforcement in the fireproofing and so develop a combination beam in which the reinforced masonry carries a substantial part of the load? Recent tests indicate that such a combination functions satisfactorily and that the strength of a steel I-beam combined with a reinforced-brickwork beam (the brickwork also furnishing the fireproofing) is about four times as strong as the bare steel beam.

In view of these facts is it not reasonable to assume that the whole outer steel framing may be safely made much lighter and hence less costly? It seems entirely feasible also to reduce the weights and costs of outer inclosure walls without going far afield in any search for new materials, if we wish to use present knowledge to good advantage.

Suggested design

Without further discussion, let me suggest a design that should meet all requirements and probably be less expensive than any other wall type that will likewise meet service requirements. Figs. 1 and 2 indicate the details.

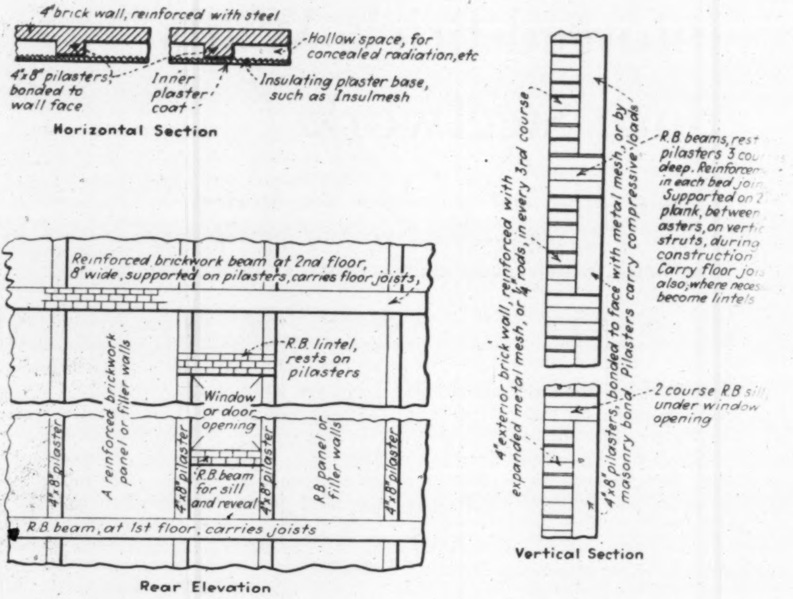

4" brick wall, reinforced with steel
-Hollow space, for concealed radiation, etc
4"x8" pilasters, bonded to wall face
Inner plaster coat
Insulating plaster base, such as Insulmesh
Horizontal Section
Reinforced brickwork beam at 2nd floor, 8" wide, supported on pilasters, carries floor joists,
R.B. lintel, rests on pilasters
Window or door opening
A reinforced brickwork panel or filler walls
4"x8" pilaster
4"x8" pilaster
4"x8" pilaster
4"x8" pilaster
R.B. beam for sill and reveal
R.B panel or filler walls
R.B. beam, at 1st floor, carries joists
Rear Elevation
4" exterior brick wall, reinforced with expanded metal mesh, or ¼" rods, in every 3rd course
4"x8" pilasters, bonded to face with metal mesh, or by masonry bond. Pilasters carry compressive loads
R.B beams, rest pilasters 3 cou deep. Reinforce in each bed join Supported on 2 plank, between asters, on vertic struts, during construction Carry floor jo also; where neces become lintels
2 course R.B sill under window opening
Vertical Section

Fig. 2—Reinforced-brick wall construction for residences with self-supporting walls carrying floor joists.

The framing will consist of structural-steel members, the columns well incased in masonry, with spandrels of combination steel and reinforced masonry beams, the masonry in each case forming the fireproofing for the steel.

Panel, or inclosure, walls may be either 4 in. of reinforced brickwork or its equivalent in reinforced concrete, if the appearance of bare concrete is deemed satisfactory. To meet fire-resistance requirements, it may be necessary to increase this wall thickness to 8 in.

In order to provide masonry depth for pleasing window reveals, 8-in. or 12-in. pilasters next to window frames may be necessary. But such pilasters, together with the column masonry, will provide the base for fastening plaster grounds. The inner plaster coating thus incloses a hollow space within the wall that may be utilized as a chase for piping and for electric conduit. It may also be used for concealed radiation, or to carry the piping for a modern panel heating system, thus removing all radiation from the outer rooms. Such construction, using only 4-in. reinforced brickwork walls, has been satisfactorily used in England for several years. There is no apparent reason why such walls should be unsatisfactory in this country.

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Low Accident Record for Cement Industry Over Nine-Year Period

ACCIDENTS to workmen in the cement industry have been reduced more than 95 per cent in the last nine years, according to a tabulation just released by the Portland Cement Association. The figures show only 130 accidents severe enough to cause loss of time from work at member mills during 1932. This compares with 3,118 accidents in 1924. The frequency rate (number of accidents per 100,000 man-hours worked) has dropped from 3.5 to 0.45, or about 84 per cent, over the same period of years.

Much of the safety progress made by cement plants in recent years is attributed to the work of the association's committee on accident prevention and insurance. An outstanding feature of the safety program has been the safety contest conducted annually since 1923 among cement plants. Except for the first year of the contest, the prizes have gone to mills that operated without a single accident for the twelve months.

Although the cement industry is potentially one of the most hazardous, it led all industries reporting to the National Safety Council in low accident frequency for four consecutive years through 1931, and earned third place in 1932.

In 1924 one mill had a perfect record, the first ever achieved in the industry. There were 2 winners each in 1925 and 1926, 10 in 1927, 17 in 1928, 26 in 1929, 43 in 1930, 36 in 1931, and 41 in 1932. In all, 88 individual plants have received prizes, having operated at least one calendar year with a clear safety record. Two mills have operated more than six years since their last accident, another more than five years, and ten others more than 1,000 days.

Gunite Retains Integrity on Oregon Road Bridges

Incasement placed in 1922 and 1929 shows no deterioration with the exception of a few hair cracks as disclosed by careful survey made in 1932

By C. B. McCullough
Assistant State Highway Engineer, Salem, Ore.

THE TWO BRIDGES described in this article exhibit both a recent and a fairly old example of steel incasement with gunite. Recently a careful inspection was made to determine the condition of this incasement, and the results appear of interest, particularly in the case of the structure at Oregon City. This bridge was described in *Engineering News-Record*, Nov. 2, 1922. A view of the bridge is shown in Fig. 1 and of the method of applying the incasement in Fig. 2.

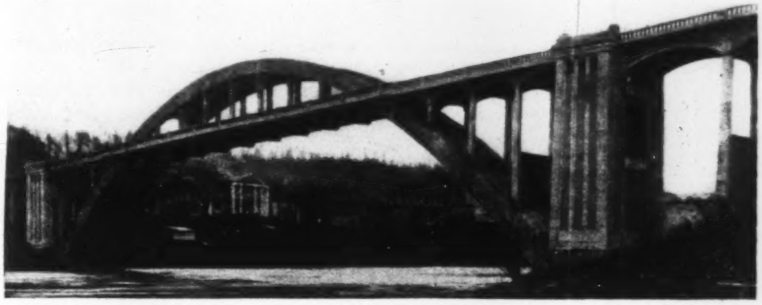


Fig. 1—Steel box-section arch-rib bridge completed in 1922 at Oregon City, Ore., with incasement of all steelwork.

Oregon City Bridge

The Oregon City Bridge carries the traffic of the Pacific Highway across the Willamette River at Oregon City and consists of one central fixed-arch span 360 ft. long flanked by a reinforced-concrete viaduct approach at either end, the entire structure being 745 ft. long. The arch ribs are closed box-girder sections braced at frequent intervals throughout their length by radial diaphragms. Suitable openings are provided in the rib sections at the crown for inspection, and the solid steel diaphragms are fitted with manholes to permit easy access from end to end of the rib sections on the inside. The structure replaced a suspension bridge with timber towers and stiffening trusses, and the erection program contemplated the use of the old cables, as indicated in Fig. 4.

The exterior of the box-girder arch ribs was protected by an incasement 1½ in. thick, the method of application being substantially as follows: The entire exterior was covered with a network of 3.8 in. round rods spaced 12 in. center to center both ways, and spot-welded to each other and to the structural steelwork at each intersection. This system served as an anchorage for a layer of triangular wire mesh subsequently placed and securely wired thereto. Below the deck the ribs were braced at each panel point by means of steel trusses the full depth of the rib. The individual truss members were incased, and the entire system was then converted into a solid girder by means of a gunite diaphragm shot against a temporary timber backwall.

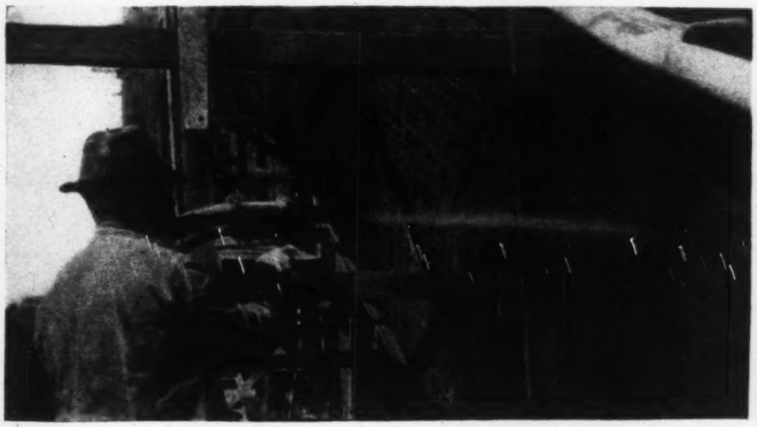


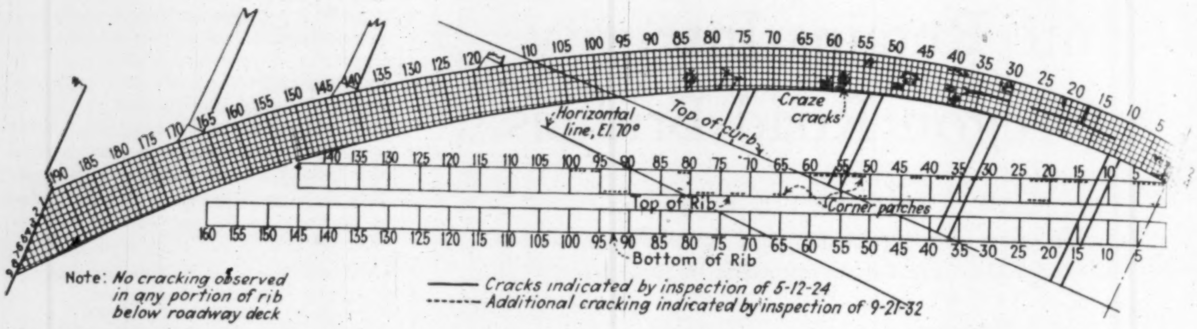
Fig. 2—Guniting arch rib of Oregon City Bridge; ⅜-in. bars 12 in. apart both ways, spot-welded at intersections to arch steel, anchored the reinforcing mesh.

Shortly after the construction of the bridge a series of drawings, as indicated in Fig. 3, was prepared for the purpose of carefully locating any cracks that might be observed to develop as the structure progressed in service. It will be noted on the sketch that the entire arch-rib surface is coordinately ruled so that the exact location of any particular crack or blemish may be quickly obtained. Fig. 3 indicates the formation of hair cracks as disclosed by two inspections: May 12, 1924, and Sept 21, 1932. This figure represents only one side of one-half of one vertical-rib surface; however, this particular part of the rib is typical of the entire structure.

An inspection of Fig. 3 will disclose the fact that there are no cracks, blemishes or defects of any nature on that portion of the work below the deck. This is true for the entire structure. Above the deck a few cracks have developed, but in nearly every case the cracking observed in 1932 was disclosed by the 1924 inspection. In other words, very few new cracks have developed during the eight-year period between these two inspections.

In order to ascertain the degree to which the cracking observed above the roadway deck might operate to impair the service life of the structure, the gunite was chiseled away in several places, and it was found that the cracks could not be traced beyond a depth of from ⅛ to ¼ in. below the surface, indicating that the trouble was undoubtedly a surface condition. The incasement was placed in two layers, the last one being a very thin flash coat employed for the purpose of smoothing up the surface, and it seems quite apparent that very few, if any, of the hair cracks observed extend beneath this finish or flash coat.

During the course of construction, tests were made on several gunite slabs, approximately 1½ in. thick, shot onto steel plates 8x½ in.x4 ft. These specimens were placed, with the steel side down, over knife-edge supports 46 in. apart and downwardly acting loads applied midway between supports. The table on page 260 indicates the observed modulus of elasticity and extreme fiber stresses at failure for five of the slabs thus tested. The beams were designed so that the gunite would fail at a comparatively low working stress in the steel, and it is interesting to observe



Note: No cracking observed in any portion of rib below roadway deck
Horizontal line, El. 70°
Top of curb
Craze cracks
Top of Rib
Corner patches
Bottom of Rib
Cracks indicated by inspection of 5-12-24
Additional cracking indicated by inspection of 9-21-32

Fig. 3—Typical sketch employed in recording cracks in incasement. Sketch shows crack record of 1924 and 1932 surveys.

the relatively high elastic modulus (4,670,000 lb. per sq.in.) and the high average ultimate strength (8,000 lb per sq.in.) of the material.

The incasement as applied on the Oregon City Bridge resulted in an exceptionally dense and hard protective coating and, with the exception of the few hair cracks noted, a service record of ten years indicates no deterioration of any character whatsoever, notwithstanding the fact that the structure is exposed to an atmosphere often rather heavily laden with sulphite fumes from two large paper plants in the immediate vicinity.

The employment of a steel rib of hollow box-girder section incased in gunite not only operated to save a considerable sum as against the cost of a solid concrete rib section but also greatly simplified certain erection problems that had arisen.

MODULUS OF ELASTICITY AND ULTIMAT STRENGTH OF TEST SPECIMENS OF GUNIT USED ON OREGON CITY BRIDGE

Specimen No.	Elastic Modulus (Lb. Per Sq.In.)	Ultimate Streng at Failure (Lb. Per Sq.In
1	4,800,000	6,360
2	3,800,000	7,980
3	5,350,000	9,250
4	5,100,000	9,780
5	4,300,000	6,620
Average	4,670,000	8,000

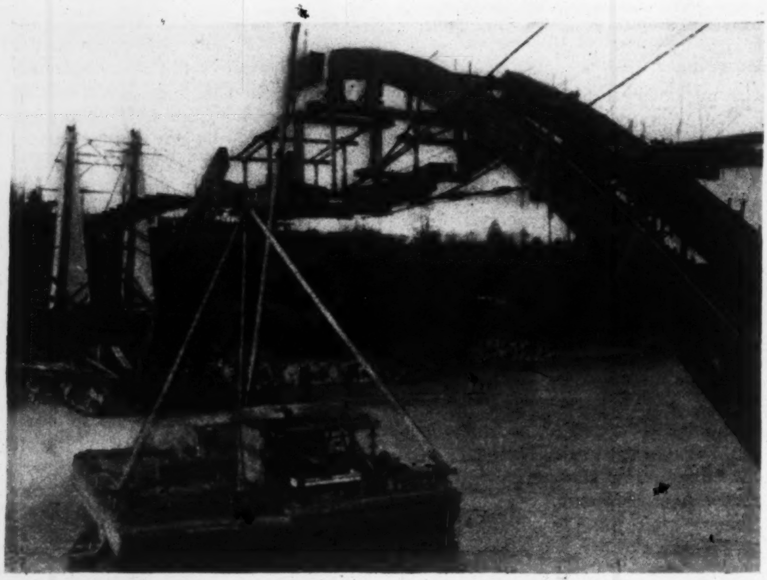
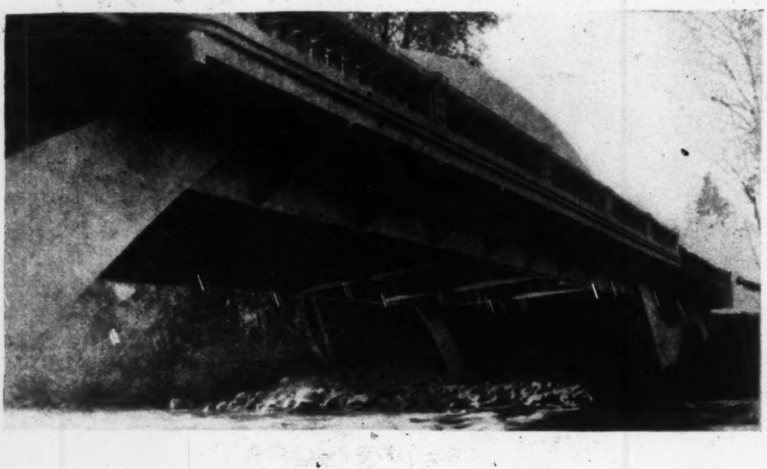


Fig. 4 (above)—Old suspension bridge, replaced by new arch, was utilized in erecting the new steelwork for the Oregon City Bridge in 1922.

Fig. [illegible] (below)—Under-side view of McKenzie River Bridge, showing incasement of steelwork with no cracks after three years.



McKenzie River Bridge

The bridge across the McKenzie River was built in 1929. It consisted essentially of a curved-chord, steel pony truss of 100-ft. span supported on cantilever arms forming a main central span of 130 ft. The cantilever arms are of reinforced concrete, with suitable structural steel anchorages to carry the negative bending back into the adjacent flanking approach spans. The suspended span is, as above stated, an ordinary curved-chord, steel pony truss, the top chord and diagonals of which were incased in concrete, while the bottom chord and lower lateral system were gunite-incased. Fig. 5 indicates the general appearance of the incasement around the lower chords, lateral system and sidewalk brackets. A very careful inspection of this structure failed to disclose any evidence of hair cracking, checking or any surface disintegration after three years of service.

* * *

Santiam River Water Power

A study of the potential water power of the Santiam River basin in Oregon has been completed by Benjamin E. Jones, hydraulic engineer, and Arthur M. Piper, geologist, of the U. S. Geological Survey. Without storage the river can produce 143,000 hp. for 90 per cent of the time and 447,000 for 50 per cent of the time. With storage reservoirs outlined in the report to the Survey, these figures will be increased to 351,000 and 492,000. Fourteen power sites are listed and seven reservoir sites. Reconnaissance of the geology at many of the dam sites was made by the geophysical method. Copies of the reports are available in the district office at Portland, Ore., or in the Washington office.

The Yellow River—

A Major Flood Menace in China

Present flood serves to emphasize the river's constant menace to wide areas in densely populated alluvial plain—Control works inadequate—Record of 2,000 years shows many changes in river channel

By Arthur M. Shaw

Consulting Engineer, New Orleans, La.
Formerly Consulting Engineer for the Chinese National Construction Commission and Chekiang Provincial Government

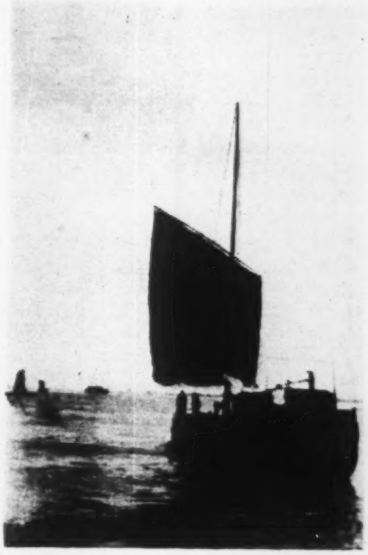
ALTERNATING between famine from drought, floods from one or another great river, internal dissensions and foreign aggression, one wonders that the Chinese people have survived, or having survived, that they have the spirit to carry on. Only two years ago the whole world was shocked by the accounts of an unprecedented flood in the Yangtse River valley, and now there are reports that the Yellow River has broken through its dikes in the vicinity of Kaifeng and is spreading over the great alluvial flats of Honan, Shantung, Anhwei and Kiangsu provinces.

The sketch maps published with the press dispatches indicate that the overflow is on both sides of the Yellow River, but the wording of the dispatches does not bear this out, though there appear to have been several breaches in the south or right-bank levees. Kaifeng, as on several previous occasions, appears to be in the most imminent danger of any city of importance. As it is only a few miles from the river and apparently in the path of one of the main breaks, it may be expected that it will suffer heavily.

To realize what such a flood may mean, one should refer to a map of China and imagine the advance of the yellow waters, sometimes rushing as a torrent and at other times slowly creeping over the whole area lying between the Yellow and the Yangtse rivers. With a break as serious as that of 1887, coupled with a major flood in the upper Yellow River, it is possible that a great portion of this area, which is nearly the size of the combined states of New York and Pennsylvania, may be submerged. While there are no cities of first-class importance in this section, it is possibly as densely populated as the two states mentioned, even taking into account their great metropolitan centers. With such congestion, and with most meager means of transportation, it is not strange that the loss of life from the great floods of the past has been measured in hundreds of thousands.

Lying between the Yellow and the Yangtse rivers is the unimpressive Hwai River, a stream which, had it not been for obstructions caused by the Yellow River overflows, never would have presented a serious flood problem but which now frequently spreads disaster.

While the deltas of these three rivers of eastern China adjoin, and even overlap each other, they do not present the appearance of ordinary river deltas, for in looking across the country on a clear day, mountains may be seen in almost any direction. On the horizon they give the impression of a continuous range, though actually they are either isolated hills or comparatively small groups of great hills. One can easily imagine that, before the building of these deltas by river silt, the China Sea covered this whole territory, but with occasional and scattered mountain islands such as one now sees in cruising through the Cushan Archipelago. The mountain islands remain, but they are now surrounded by fields of rice, wheat and kaoliang, with villages and towns at close intervals. One seldom sees farm houses, as we know them in this country, for practically the entire population lives in villages. The farms are tiny affairs of a few acres but support families averaging, in this locality, slightly less than six persons.

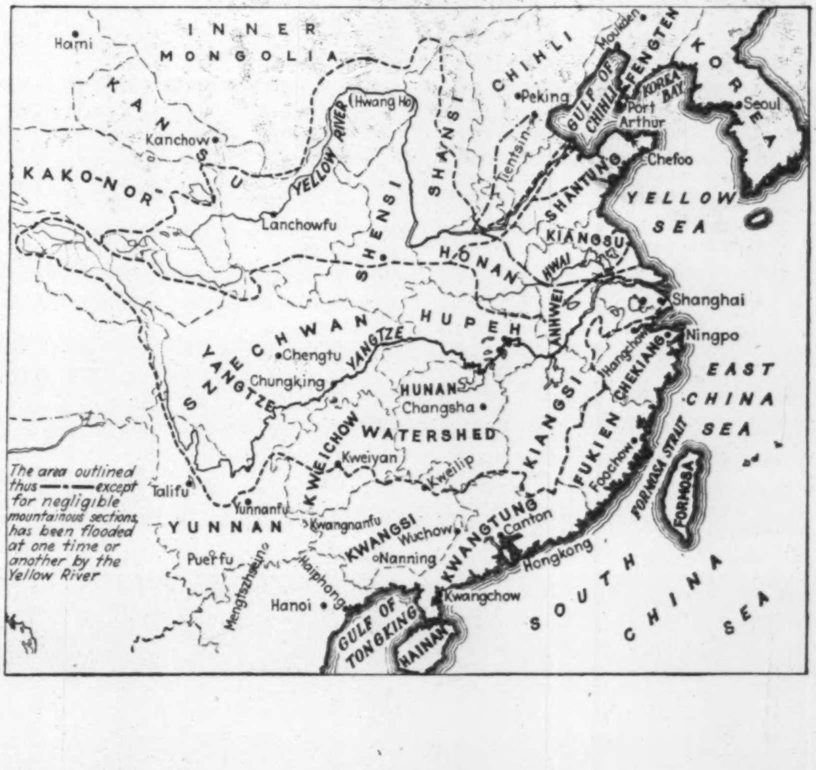


China's commerce moves largely over the surface of its broad rivers.

Railways and canals

Two trunk-like railways cross the delta country: the Tientsin-Pukow Railroad, forming a link in a continuous, government-owned route from Hangchow to Peking; and the Peking-Hankow Railroad. The latter crosses near the apex of the delta cone, hence is little affected by the floods excepting in

Major rivers and watersheds of China. The Yellow, Yangtse and Hwai rivers all reach the ocean through the same delta region.


INNER MONGOLIA
Hami
KANSU
Kanchow
KAKO-NOR
YELLOW RIVER (Hwang Ho)
Lanchowfu
SHENSI
SHANSI
CHIHLI
Peking
Tientsin
GULF OF CHIHLI
FENGTEN
Moukden
KOREA BAY
Port Arthur
KOREA
Seoul
Chefoo
SHANTUNG
YELLOW SEA
KIANGSU
HONAN
HWAI
ANHWEI
Shanghai
Ningpo
Hangchow
CHEKIANG
EAST CHINA SEA
HUPEH
SZECHWAN
Chengtu
Chungking
YANGTZE
HUNAN
Changsha
WATERSHED
KIANGSI
FUKIEN
Foochow
FORMOSA STRAIT
FORMOSA
KWEICHOW
Kweiyan
Kweilip
The area outlined thus —·— except for negligible mountainous sections has been flooded at one time or another by the Yellow River
Talifu
Yunnanfu
YUNNAN
Kwangnanfu
KWANGSI
Wuchow
Nanning
KWANGTUNG
Canton
Hongkong
Puerfu
Mengtszhsien
Haiphong
Hanoi
Kwangchow
GULF OF TONGKING
HAINAN
SOUTH CHINA SEA

the immediate vicinity of the river crossing. Reports indicate, however, that the bridge at this crossing is in imminent danger. It consists of 50 through-girder spans of 105 ft. each and 52 deck-girder spans of 66 ft. each. All spans rest on iron screw-pile bents. The total length is 8,682 ft.

Information given to prospective designers when reconstruction of this bridge was being considered in 1920 is indicative of the character of the river. The deepest observed scour below the bed at the pile bents is 11 meters; maximum "single-spot" velocity, 3 m. per second; cross-section at maximum flood, 10,000 sq.m. and 1,000 sq.m. at low water: maximum flow 530,000 sec.-ft. Much deeper scour was anticipated around the masonry piers in the proposed new structure. The latter was not built, however, and the old pile bridge with minor repairs is still in service.

The Tientsin-Pukow line is not so fortunate in its situation as the Peking-Hankow line, for its entire main line of over 600 miles is within the delta area. Its embankment is generally above the level of ordinary floods, but it has been breached on numerous occasions when attacked by the main force of flood currents. The crossing of the Yellow River is by a modern, steel, through-truss bridge that is above maximum flood-level. The crossing is a few miles north of Tsin An, the capitol of Shantung Province.

The German-built railway running from Tsin An to Tsin Tau is wholly within the delta, as is also the eastern half of the recently completed Lung-Hai Railway, which is an east-and-west line built by the Chinese.

Running roughly parallel to the coast line, the Grand Canal crosses the delta cone approximately midway of its height. Connecting with the Grand Canal are innumerable smaller canals on which the commerce of the interior is mainly dependent, as the territory is almost wholly lacking in highways and wheeled vehicles. As might be expected, this network of canals suffers the least from a major flood of all the improvements, though some units may be badly filled with sediment.

Great destruction of homes

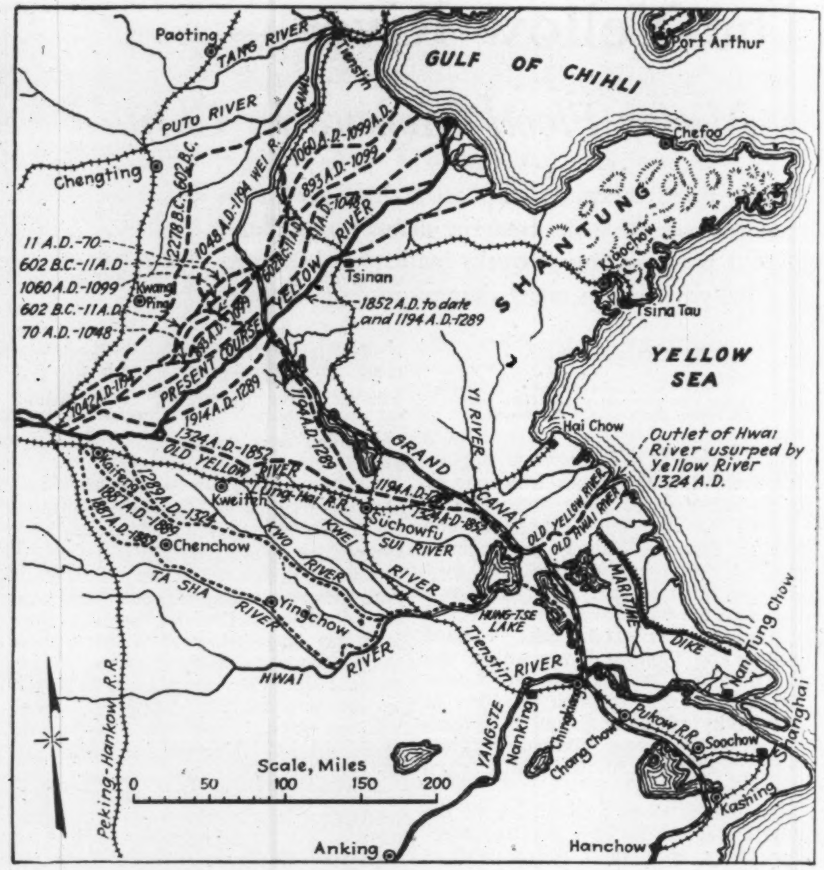
Aside from the loss and destruction of crops, the wrecking of homes is probably the greatest cause of suffering among the people of the flooded areas. The walled city of Kaifeng, the capitol of Honan Province, was once almost wholly destroyed and has suffered serious damage on several occasions, but, being near the head of the delta, not all the floods reach it. It is a city of about 250,000 population.

The homes of the poorer classes, and even of the moderately well-to-do, are usually built with mud walls that will crumble if even partially submerged for several days. The material used in the walls is somewhat similar to the Texas and Mexican abode, but the Chinese, instead of making large, sun-dried brick, as do the inhabitants of both sides of the Rio Grande, put the mud directly in place and tamp it there.

The better buildings, and even the great mud walls that are built around private compounds, may be given a coat of plaster made of fine sand, or perhaps mud, mixed with lime. The lime is brought to a paste by the use of water in which rice has been boiled. Such mortar offers considerable resistance to water, and the plaster coat adds materially to the life of a mud wall.

Effect on crops

Yellow River floods occur in the summer months, and if they come in June or July they are certain to destroy much of the early crops, and in case of a long-continued overflow they make impossible the planting of a late crop. Frequently both crops of the year are lost. Cultivation usually is possible almost immediately after the water has drained off the land. The deposits of silt may act as a fertilizer, greatly increasing the succeeding crops. In this respect, conditions are quite different from those following some of the floods of the Mississippi delta where sand may be spread over the land.


Paoting
TANG RIVER
Tientsin
GULF OF CHIHLI
Port Arthur
PUTO RIVER
CANAL
WEI R.
Chengting
602 B.C.
2278 B.C.
1048 A.D.-1194
1060 A.D.-1099 A.D.
893 A.D.-1099
11 A.D.-1048
602 B.C.-11 A.D.
11 A.D.-70
602 B.C.-11 A.D
1060 A.D.-1099
602 B.C.-11 A.D
70 A.D.-1048
Kwang Ping
YELLOW RIVER
Tsinan
1852 A.D. to date and 1194 A.D.-1289
PRESENT COURSE
1042 A.D.-1194
893 A.D.-1099
1914 A.D.-1289
1194 A.D.-1289
Chefoo
SHANTUNG
Kiaochow
Tsing Tau
YELLOW SEA
YI RIVER
GRAND CANAL
Hai Chow
Outlet of Hwai River usurped by Yellow River 1324 A.D.
1324 A.D.-1852
OLD YELLOW RIVER
Kaifeng
1289 A.D.-1324
1887 A.D.-1889
1887 A.D.-1889
Kweiteh
Lung-Hai R.R.
1194 A.D.-1289
1324 A.D.-1852
Suchowfu
SUI RIVER
KWO RIVER
KWEI RIVER
Chenchow
OLD YELLOW RIVER
OLD HWAI RIVER
MARITIME DIKE
TA SHA RIVER
Yingchow
HUNG-TSE LAKE
Tientsin Pukow R.R.
Tung Chow
HWAI RIVER
YANGTSE RIVER
Nanking
Chinkiang
Chang Chow
Pukow R.R.
Soochow
Shanghai
Peking-Hankow R.R.
Scale, Miles
0 50 100 150 200
Kashing
Anking
Hanchow

Delta region of the Yellow, Hwai and Yangtse rivers, showing the many channels occupied by the Yellow River. This map is based on one prepared by John F. Freeman for his paper on "Flood Problems in China" (*Transactions*, Am.Soc. C.E., Vol. 85).

Rivers in the delta area

The three rivers which have built up the great delta area of China not only differ widely in length and area of drainage basins, but each presents a problem peculiar to itself, as will be seen by the following tabulation and description of the individual streams.

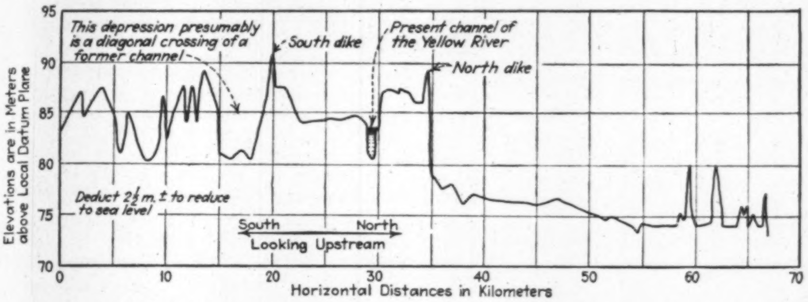
River	Floodflow in Sec.-Ft.	Miles of Main Stream	Sq.Miles of Drainage Basin
Yellow	500,000	2,400	300,000
Hwai	250,000	800	50,000
Yangtse	3,000,000	3,000	500,000

The above figures should be used with caution, as they have been derived from various sources and may be considered as only roughly approximate. The apparent disproportion of flood-flow of the Yellow River, as compared with the other two, may be partly explained by the fact that much of the area included in the drainage basin of the former is arid or semi-arid. Beyond the headwaters of the Yellow River are thousands of square miles of land from which there is no runoff, the evaporation equaling the slight rainfall. Brackish and salt lakes abound in this section.

Historical records

In no other country is there such a wealth of authentic and fairly continuous records of engineering works, and of phenomena to which such works are related, as may be found in China. Some writers place the beginning of authentic history as far back as 3,000 years before Christ, though the more conservative place the "beginning of the historical period" at about 1150 B. C., with the "beginning of the period authenticated to some extent" at 2200 B. C. Partly supported legends extend much farther back.

Though the bulk of the early writings are concerned chiefly with the affairs of state and matters of particular interest to the rulers, careful delving and sorting have made available a great store of information concerning past floods, famines, advance and recession of shore lines, land tenure and other matters of interest to the engineer, the scientist and the student of social welfare.



A cross-section of the delta region at Kaifeng. Adapted from a section prepared by John R. Freeman.

The Yellow River

Both the mean and the floodflows of the Yellow River are far below those of the other great rivers of the world, but no other river has such a history of disastrous recurring floods as has this one. The main reason, it is generally agreed, is the amount and character of silt that is transported during flood periods.

For practically its entire length the river flows through a loess formation that is easily eroded and consists of extremely fine grains. Practically none of these are retained on a 200-mesh sieve, yet a test tube filled with the most turbulent of floodflow samples will become practically clear in less than half an hour of undisturbed precipitation. The behavior of the material indicates that it is not only extremely fine, but that there is a great uniformity in the size of grains, hence a unanimity of action at given velocities. This assumed uniformity in size, shape, specific gravity of the particles will do much to explain the rapidity of channel changes that occur in the delta area of the Yellow River.

Much has been done by the Chinese engineers, aided at times by the foreign advisers, in recording river stages, measuring floodflows and securing other hydraulic data, but their studies have not been complete and, especially, it has not been possible to keep continuous records covering a considerable portion of time. Some valuable information bearing on scour and refill has been secured, however. During the flood of the summer of 1919 a series of soundings was taken. These sections are shown in the accompanying section from John R. Freeman's paper on "Flood Problems of China" (*Transactions*, Am. Soc.C.E., Vol. 85).

Of particular interest in these sections is the rapid adjustment of the bed of the river. Disregarding the increased section secured by an increase in level of water surface, the cross-sectional area of the channel was increased by erosion from 395 sq.m. on May 7, to 1,996 sq.m. on July 24, an increase of 500 per cent in 78 days. Almost as remarkable is the rapidity of refilling, the area on Sept. 26 having fallen back to 420 sq.m. Note particularly that these areas include only the sections below the low-water flow of May 7, hence they represent scour and refilling only.

From these figures it would be reasonable to expect (and the hypothesis is borne out by observed conditions) that a given floodflow will be much more likely to cause breaks in the levee system if the peak follows closely after the initial rise than if there is a gradual increase in flow, which will increase the channel section by scour as the flow increases.

No data are available showing the maximum amount of solids carried in suspension by the Yellow River, but it is claimed by two or more authorities that solids up to 10 per cent of volume have been observed. Such a percentage would be creditable for a hydraulic dredge working in any but the most favorable material. Various writers make reference to a semi-solid mass of mud that is moved along the bed of the river when in flood, but they have failed to furnish conclusive evidence of the phenomenon. In his studies of the Yellow River, John R. Freeman investigated the point and was convinced that there was no such wholesale movement of solids along the riverbed. He lays continued stress, however, on the tremendous volume of silt carried in suspension and its important bearing on the problem of river control. Practically all other modern technical men who have studied the river problem are agreed on this point, but there is no such agreement in their suggested remedies.

Control works

Control by levees only seems to have been the policy of those in charge of the Yellow River for ages past, and few (if any) have had the temerity to suggest a substitute for the levee method, though channel rectification has been recommended as an auxiliary measure and great emphasis has been placed on the benefits that would be gained by preventing erosion in the catchment area, thus reducing the amount of silt brought to the river.

The levees generally are set well back from the river, often being from 4 to 8 miles apart, though there is a great lack of uniformity in the distance between them. It is probable, as claimed by many engineers, that if a complete hydrographic survey of the river is made, it will be found possible to design a system of levees, with bank-protection works, which will maintain a more uniform velocity throughout the year, thus overcoming, to a considerable degree, the lack of main channel capacity that is found after a period of low water.

Practically all levees and similar constructions in China are built by hand labor, the material being transported in baskets hung at the ends of shoulder poles so frequently seen in Chinese views. As the material is dumped in small quantities, carefully spread and tamped, an excellent enbankment is secured which seldom gives trouble from seepage.

Local protection from erosion both of river banks and levees, is most frequently secured by fascines of kaoliang stalks (a giant millet). Some riprap is used, but in most of the delta country rock can be secured only from distant sources, and its use is limited.

Character of the Delta

In riding across the delta from the Yangtse River to Tientsin, one is continually crossing depressions which give evidence of once having served as the bed of an important stream. In the case of the Yellow River, only a few years of occupancy of a course has resulted in substantial modification of the topography of the country, the accretions from silt-laden waters being unbelievably rapid. The "natural levees," resulting from a general overflow of banks, are present everywhere, and frequently there may be seen carefully constructed artificial embankments now miles away from any stream of importance. In this area, as probably would not be possible in any other part of the world, one may "tie up" geological processes with periods of written history. Here the changes consist mainly of a general building up of one portion after another of the delta cone, frequent cutting of new channels, and a rapid moving outward of the coast line. A contributing factor to the rapidity of the latter process is the comparative shallowness of the China Sea, a condition which again aggravates conditions in the river as the rapidly increasing distance to a free outlet to the sea reduces the gradient and adds to the difficulty of accommodating the floodflow within the channel.

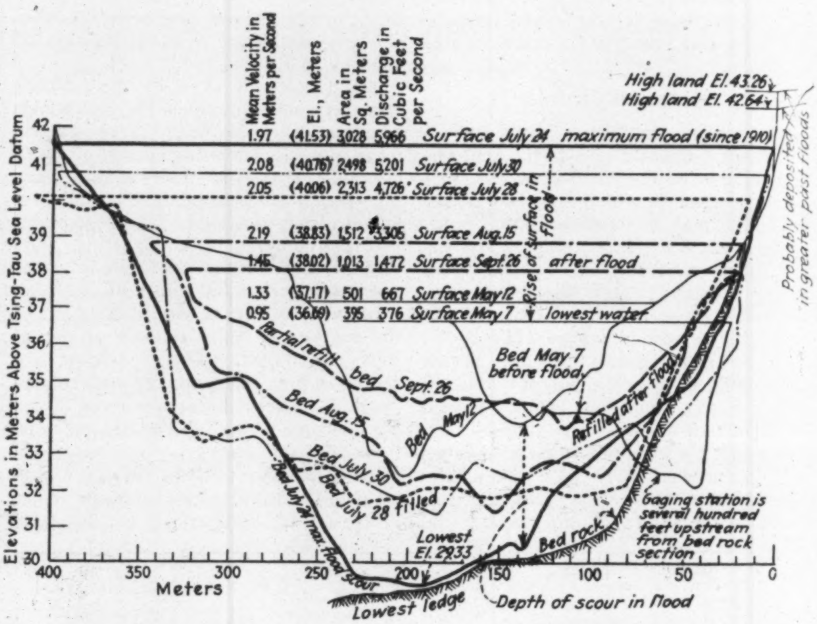
Although most of the coast line along the combined delta frontage is advancing seaward, the opposite condition holds true in the extreme southern portion of the Yangtse delta, where considerable recession has taken place. On a map that the writer had occasion to consult only recently, the site of a market town was shown 12 miles out from the present shore line, at a point where there is now a 40-ft. depth of water. The town disappeared into the sea about 1,200 years ago.

The Hwai River

Until the usurpation of the bed of the Hwai River by the Yellow, the former stream had never been the cause of serious floods. Its channel easily accommodated the flow from its comparatively small drainage area, and much of the land now occupied by lakes and marshes formerly was occupied by farms and villages. The change was brought about by the several hundred years of uncontrolled flow of the Yellow River to the southeast. The initial break occurred in the year 1194 and continued until 1852, when it returned to its former outlet into the Gulf of Chihli. Again, in 1887, a break occurred in the south bank of the Yellow River, the waters reaching the Hwai through the Da Sha and the Kwo rivers. The break was repaired in 1889.

The original outlet of the Hwai River into the sea was at a point about 200 miles north of the mouth of the Yangtse, but the yellow mud from the invading river entirely blocked this outlet and the approaching channel, building a ridge to such a height that it could not be surmounted by the Hwai River even when at flood stage. Some of the water now escapes by minor outlets directly to the sea, but the most of it discharges into numerous lakes to the south of the old channel, and finally finds its way to the Yangtse River.

Until a suitable outlet is provided for the Hwai River, disastrous floods of frequent occurrence may be expected from this source. From an engineering viewpoint, the solution of the problems presented by the Hwai River does not appear to be so unsolvable as those of the Yellow River, but unless full assurance can be given that the latter will not again invade the territory of the smaller stream, the wisdom of spending the millions that will be required in providing an adequate outlet for the Hwai River may be in doubt.



The cross-sectional area of the Yellow River increases greatly in time of flood, as indicated by this section prepared by John R. Freeman.

The Yangtse River

The greatest flood ever recorded in the Yangtse River occurred only two years ago, when the crest at Hankow reached a point nearly 3 ft. higher than previous records. The details of this flood are still fresh in the minds of most who are at all interested in the affairs of China, and as the floods of the Yangtse have been described quite in detail, in publications readily available in this country, these will be discussed only briefly.

The general characteristics of the Yangtse River and of its floods are similar in many respects, to those of the Mississippi, though there are some marked differences. For example, on the Yangtse there are many large lakes at various points in the lower valley and innumerable smaller ones. Under a wise plan of control, and at a reasonable cost, these could be made available for use as regulating basins. The largest of these lakes is Tung Ting Hu, with an area of perhaps 2,000 square miles. As this lake is situated well above Kankow, and more than 700 miles above the mouth of the river, it affords considerable relief at times of maximum flow. Below Hankow there is a large number of smaller lakes, and two which approach in size Tung Ting Hu. All of these assist to some extent in storing floodwaters, though their effectiveness has been somewhat reduced by reclamation along their edges in several cases.

There can be no doubt that if the Yangtse River Commission were given full control over all these connecting lakes, a substantial reduction in flood crests could be effected. By improving the channel connection to each lake and by putting in control works at each connection, it would be possible to prevent the Yangtse water from entering the lakes until a danger point is reached, and then to drain water from the river rapidly to the full reserve capacity of each lake. With the present uncontrolled connections, the lakes are gradually filled while the river is yet at a moderate stage, and thus their capacity for emergency relief is greatly reduced.

This method of employing adjacent lakes, with controlled connections to the river, is not unknown in China. Only a few years ago the writer assisted in the preparation of plans for the control of floods of the East Tio River, in Chekiang Province. Here we found that two large "lakes" had been utilized for generations in exactly the manner above suggested for use on the Yangtse. Unfortunately, the accumulations of silt, from two or three centuries of use, had so reduced the capacity of these lakes that other relief measures were required.

The Grand Canal

Excepting in its northern (and sadly degenerated) portion, the Grand Canal is almost entirely an artificial waterway, yet it materially affects and is affected by the floods of the Yellow River and those of the Hwai River. The canal is flanked on either side by high banks which fend off all floodflows until these reach a considerable depth over the surrounding lands, but when the floodwaters get into the canal, as they succeed in doing when there is a major flood, an auxiliary channel is thus afforded for reaching other sections and reaching them more quickly.

Centuries of experience with floods have taught the Chinese the necessity of providing safeguards at various points along the Grand Canal, and some most excellent work has been done. Emergency dams have been constructed at strategical points, provision made for spillways, and masonry weirs have been built at suitable points to isolate various sections. A definite and well-planned system of maintenance has been enforced for many years, expecting that in times of stress, these works have occasionally been neglected, and at other times they have proved to be inadequate to meet the conditions imposed by an extreme flood.

Some portions of the Grand Canal were constructed 2,000 years ago, and all of it has been in service for nearly 1,000 years, yet in no part have modern locks ever been constructed. Lockage was possible at a number of points, by use of stop-log gates operating in grooved masonry, but the most, if not all, of even these crude locks are now out of service. At each change of level in the canal, a masonry weir has been constructed, and passage at such points is made either by a portage or by dragging the boat, with its load, over the weir on what is known as a "mud slide."

During high water in one of the connecting rivers, the current running through the canal usually becomes too swift for safe navigation. As the water recedes, the Grand Canal immediately resumes its position as one of the main arteries of commerce of the country, though excessive silting from Yellow River floods is nearly always found in some sections, and the removal of such deposits is most tedious and expensive. Hand labor is cheap and excavation "in the dry" is inexpensive, but the Chinese have never devised a method for excavating, on a large scale, from under water. Machine excavation has been used to a limited extent but has not come into common use.

Public-Works Program Is Moving Forward

Organization for handling municipal projects is complete and functioning — Maximum decentralization to be maintained — Inspection separated from approval—Labor, wage and contract questions

Within the past week the Federal Emergency Public Works Administration, which up to now has authorized virtually nothing other than federal projects, completed its field organization for handling municipal projects, and that organization is now functioning. Projects are already coming into Washington headquarters with state board approval, and are going through quickly. Rapid progress is forecast in getting a large volume of projects under contract and thereby putting the fund provided by the act into service to create employment and new purchasing power.

That the delay of the past ten weeks with respect to municipal projects has brought about a seriously pessimistic attitude throughout the country concerning the public-works program is clearly recognized by the Administration. In fact, realization is general in Washington circles that the failure to get public-works money out to the wage-earner has created a critical situation. This realization is found in the Public Works Administration itself. In explanation it is said that the job of organizing for efficient use of the huge fund, under adequate safeguards, and of formulating basic policies so that rapid and sound progress would be possible once active work begins proved so large and difficult as to require weeks of time. Now that the organization is complete and in working condition—even though at some points still in skeleton form—this lost time is expected to be made up soon. Every effort will be centered on getting the largest possible amount of work under conract by early fall. The housing and federal-works divisions, which were put into working shape much earlier, are active. A number of housing loans were approved within the last three weeks.

The organization that had been developed in June, prior to passage of the act, cannot fairly be compared with the present set-up, it is said. That organization was a paper scheme only, had not been subjected to working test, and had not been fitted into the governmental machinery. With respect to the possibilities of political entanglement, it has been known for many weeks past that, even before the President approved the act, state politicians had learned that an organization was being built up to execute the public-works program, that they made insistent demand for control of this organization, and that their demand and the hazard of political control and graft wrecked the organizational scheme contemplated in June. Thereafter the program marked time for three weeks during the President's holiday, while a temporary public-works administrator and supervisory board were in charge. When finally Secretary of the Interior Ickes was named administrator, he directed the entire organizing procedure with first regard to assuring that the huge fund would be spent efficiently and honestly.

Organization for project approval

Organized as shown by diagram, Fig. 2, the Public Works Administration centers in the state-operating organizations, each consisting of a state engineer and an advisory state committee. These are tied in directly to the office of the administrator at Washington (Harold L. Ickes, administrator; H. M. Waite, deputy administrator, the latter aided by E. W. Clark, Maj. R. W. Crawford and Maj. Philip B. Fleming, executive assistants). While a full examining staff is provided at Washington, covering engineering, legal and financial matters (Clarence McDonough, director of engineering), the aim is to decentralize as far as possible. Headquarters will rely on the state engineers as fully as conditions permit. Except perhaps in the early period, it will re-examine only to the minimum extent made necessary by circumstances. Thus the system is in sharp contrast to that of the Reconstruction Finance Corp., which centered all examination and recommendation at Washington. In its present form the PWA organization is credited with being able to handle 50 projects a day and can increase that capacity.

Each state engineer's office is staffed to carry on engineering, legal and financial examination of submitted projects, but central staffs to handle these three classes of questions exist at headquarters, and each project received will, after first scrutiny by a preliminary examining board, go simultaneously to these three divisions. If approved by all three, it goes forward to the administrator for approval, and thence back to the state board for the preparation of contracts; contracts themselves are later similarly routed from the state office to headquarters for approval.

Inspection of construction work, however, is wholly centralized. The state offices are relieved of inspection responsibility, and the inspection division is part of the headquarters organization and reports to the administrator, sending copies of its reports to the state office.

Aside from the municipal-projects organization, there is under the administrator a division of federal projects (F. E. Schnepfe, director), a housing division (R. D. Kohn, director), and a division of railroad maintenance and equipment. A technical board of re-

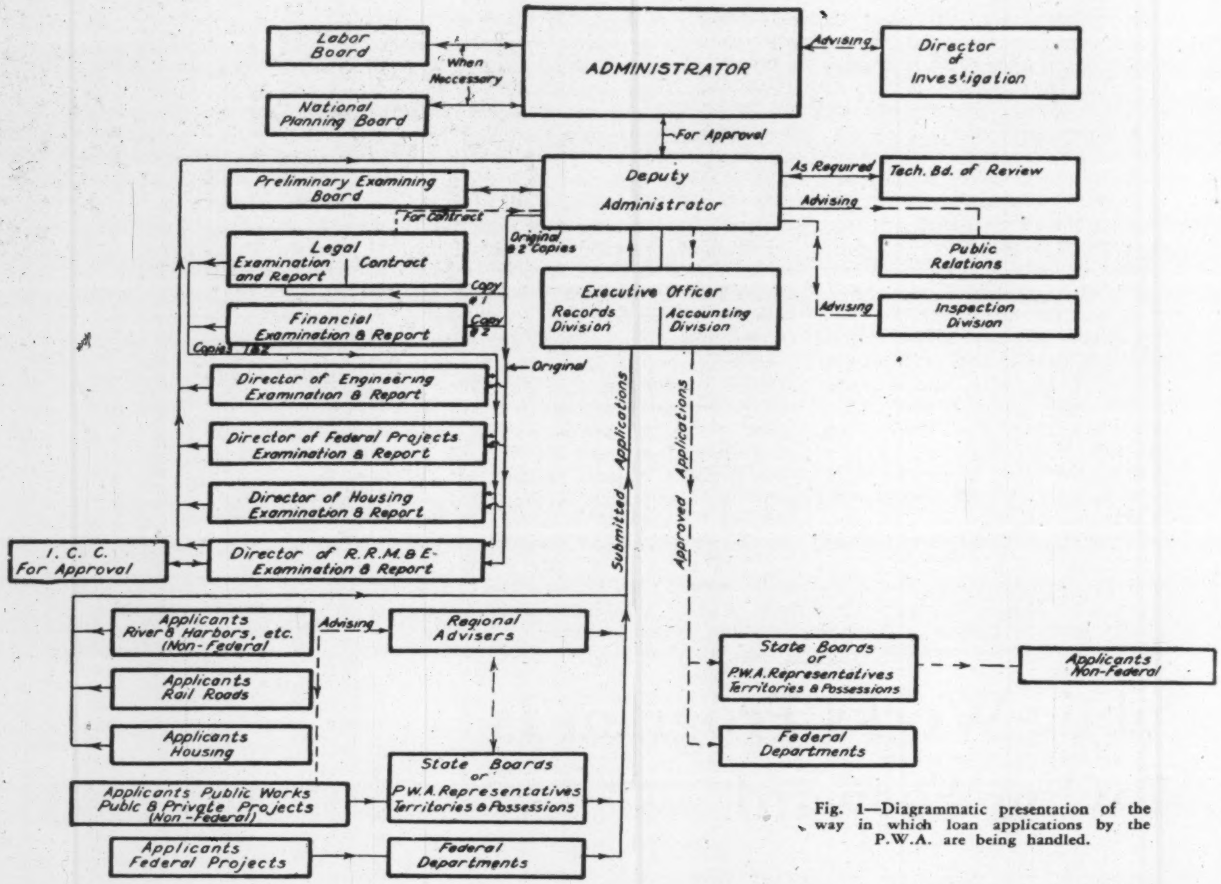

Labor Board
When Neccessary
National Planning Board
ADMINISTRATOR
Advising
Director of Investigation
For Approval
Preliminary Examining Board
Deputy Administrator
As Required
Tech. Bd. of Review
Advising
For Contract
Original & 2 Copies
Legal Examination and Report | Contract
Public Relations
Copy #1
Copy #2
Financial Examination & Report
Copies 1&2
Executive Officer
Records Division
Accounting Division
Advising
Inspection Division
Original
Director of Engineering Examination & Report
Director of Federal Projects Examination & Report
Director of Housing Examination & Report
I. C. C. For Approval
Director of R.R.M.& E. Examination & Report
Submitted Applications
Approved Applications
Applicants River & Harbors, etc. (Non-Federal)
Advising
Regional Advisers
Applicants Rail Roads
Applicants Housing
State Boards or P.W.A. Representatives Territories & Possessions
Applicants Non-Federal
Federal Departments
Applicants Public Works Public & Private Projects (Non-Federal)
State Boards or P.W.A. Representatives Territories & Possessions
Applicants Federal Projects
Federal Departments

Fig. 1—Diagrammatic presentation of the way in which loan applications by the P.W.A. are being handled.

view (Carey Brown, director) is provided for appeals. The National Planning Board (Frederic A. Delano, chairman) operates in advisory relation to the administrator, as does also a labor board of review (not yet appointed) to take care of wage and labor questions, and a bureau of investigation (L. R. Glavis, director), which operates independently of the examining, approving and executing organization.

Coordination of projects with general planning involves formulation of broad policies by the National Planning Board but is not intended to include a scrutiny of individual projects for conformity with a national plan. The regional advisers of the PWA (one in each of ten regions) will coordinate with the board in their functions of planning and project promotion.

As may be seen from the routing diagram (Fig. 1) private projects take exactly the same course as municipal projects. However, three classes of projects are not examined in the state offices but are forwarded by them direct to headquarters. These are river and drainage improvements made necessary by federal treaty obligations, housing, and railroad maintenance and equipment.

Several points of procedure important to applicants are noted in the following:

1. Full information is essential in applications. All pertinent items of Circular 2 must be supplied. Detail drawings are not required, however.

2. Headquarters will examine all projects submitted, whether approved or disapproved in the state office.

3. As grants are limited to 30 per cent of cost of labor and materials used, the amount of the grant cannot be determined precisely until completion of the job.

4. Where the engineer and the state advisory board disagree on recommendations, reasons for the disagreement must be reported by them to Washington.

5. Inquiries relating to public highways under Section 204a should be referred to the state highway department, but *applications for loans and grants to municipalities for building roads not included in the state highway program should go to the state advisory board* like any other municipal application.

To this should be added an important point of general policy—namely, that allocations from the fund to municipal projects will not be proportioned by states, but projects will be considered and approved independently.

Relative to expectations in some quarters that, despite the clear provision of the Recovery Act, grants of 100 per cent of cost may be made in some instances, it is said that there is no warrant for 100 per cent grants except possibly for flood control.

Bidding and contracts

Contracts under the PWA are required to be let to the lowest responsible bidder. The ability of a bidder to carry on the work is to be determined by the state engineer, after considering whether the contractor has adequate plant and finances, experience and a permanent place of business.

Contracts will require the contractor to conduct work in safe and workmanlike manner and to furnish compensation insurance. Wage rates must be posted on the job.

Minimum wage rates to be paid on all PWA construction were fixed recently by resolution of the special board for public works. They are in three grades, covering the Southern, Northern and Central zones, respectively: for skilled labor, $1, $1.10 and $1.20 per hour; for unskilled labor, 40, 45 and 50c. per hour, except where higher rates prescribed by collective agreements or understandings between organized labor and employers were in force on April 30, 1933. Such collective agreement rates, where there is question about them, are to be determined by the U. S. Department of Labor. Is was also decided by the board that the rates fixed are to be effective during the life of each contract, but not longer than twelve months.

Labor and wage conditions

No interpretation has been made of what shall constitute "skilled labor," and it is believed doubtful whether any subclassification of the skilled-labor group will be made by the special board or the administrator. The board's resolution says, however, that assistants, helpers, apprentices and serving laborers who work with and serve skilled journeymen mechanics shall not rate as unskilled. Wage rates for these remain to be fixed on the individual job. Present information is to the effect that such laborers as hod-carriers will be included in this classification of helpers, and that *the mere fact of their being organized will not place them in the skilled grade.*

The wage ruling quoted above *does not apply to highway work* under the $400,000,000 fund administered by the state highway departments and the Bureau of Public Roads.

All labor questions arising under contracts *or resulting from changed economic conditions* during the life of a contract will be decided by a board of labor review, to be named by the President and composed of three members representing labor, contractors and (as chairman) the administrator; but no member may be connected with any organization of building workers or with contracting, and the chairman may not be connected with the PWA.

Thirty hours per week govern all construction under the PWA, but unavoidable loss of time in any one week may be made up in later weeks of the month. Where sufficient labor is not available, 130 hours per month may be worked in place of 30 hours per week. Remote work, requiring labor camps, may (if so determined by the state engineer before bidding) be operated 8 hours per day and 40 hours per week. Sunday and holiday work is allowed only in emergency.

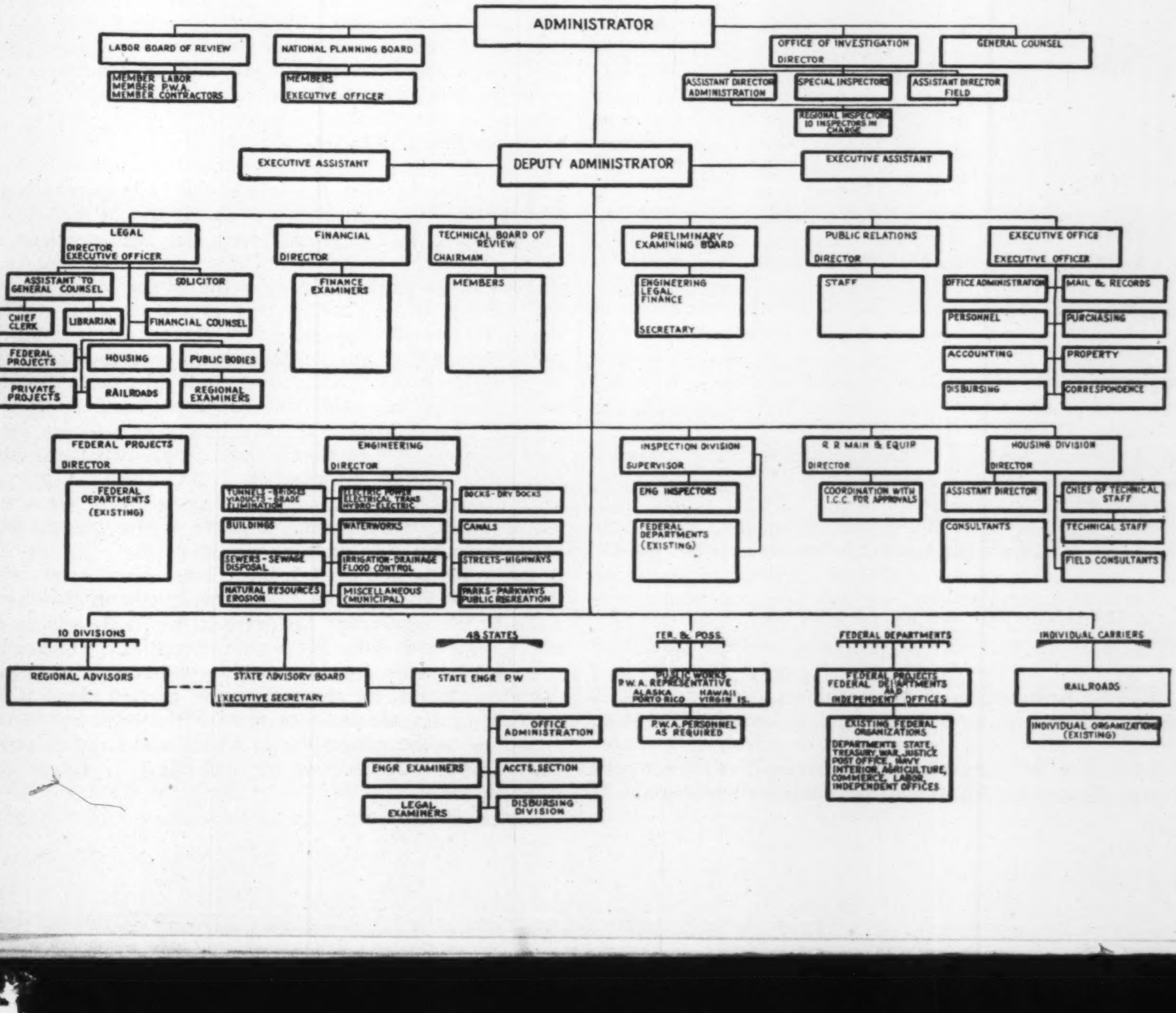
So far as possible, labor must be recruited either through union locals or through local employment agencies designated by the U. S. Employment Service (through the state re-employment director).

Some question has been raised whether the public-works wage scale will tend to fix private construction wages, inasmuch as two different wage scales (one for public work and one for private work) are not likely to exist side by side in any region. This matter is not being considered by the PWA. However, the 30-hour PWA limitation as against a higher NRA limit may tend to keep hourly rates on private work at a different level from the PWA rates.

The preceding relates largely or wholly to municipal projects. In respect to federal projects, which have received the larger part of the money allocated to date, it is likely that not all of these will go ahead at once, as some major questions remain to be settled. On Boulder Dam, for instance, where an existing contract is to be continued by the allocation of PWA money in place of regular funds that had been appropriated for the work by Congress but later were withdrawn by the President, no decision has been made as to how the wage and hour regulations of the Recovery Act and the administrator are to be applied. If the regulations hold for this job, contract price adjustments may have to be made. For this purpose an interdepartmental adjustment board is being established.

Other questions arise in connection with reclamation projects, where the procedure of application of the Reclamation Act leaves numerous uncertainties. However, some such projects, as Casper-Alcova, require much preparatory work before they are ready for contract and thus have no immediate bearing on the matter of re-employment and business recovery.

Fig. 2—Organization chart of the Federal Emergency Administration of Public Works. Decentralization of control over municipal work is provided for by having the state engineers (PWA) report direct to the deputy administrator.


ADMINISTRATOR
LABOR BOARD OF REVIEW
MEMBER LABOR
MEMBER P.W.A.
MEMBER CONTRACTORS
NATIONAL PLANNING BOARD
MEMBERS
EXECUTIVE OFFICER
OFFICE OF INVESTIGATION
DIRECTOR
ASSISTANT DIRECTOR ADMINISTRATION
SPECIAL INSPECTORS
ASSISTANT DIRECTOR FIELD
REGIONAL INSPECTORS 10 INSPECTORS IN CHARGE
GENERAL COUNSEL
EXECUTIVE ASSISTANT
DEPUTY ADMINISTRATOR
EXECUTIVE ASSISTANT
LEGAL
DIRECTOR
EXECUTIVE OFFICER
ASSISTANT TO GENERAL COUNSEL
SOLICITOR
CHIEF CLERK
LIBRARIAN
FINANCIAL COUNSEL
FEDERAL PROJECTS
HOUSING
PUBLIC BODIES
PRIVATE PROJECTS
RAILROADS
REGIONAL EXAMINERS
FINANCIAL
DIRECTOR
FINANCE EXAMINERS
TECHNICAL BOARD OF REVIEW
CHAIRMAN
MEMBERS
PRELIMINARY EXAMINING BOARD
ENGINEERING
LEGAL
FINANCE
SECRETARY
PUBLIC RELATIONS
DIRECTOR
STAFF
EXECUTIVE OFFICE
EXECUTIVE OFFICER
OFFICE ADMINISTRATION
MAIL & RECORDS
PERSONNEL
PURCHASING
ACCOUNTING
PROPERTY
DISBURSING
CORRESPONDENCE
FEDERAL PROJECTS
DIRECTOR
FEDERAL DEPARTMENTS (EXISTING)
ENGINEERING
DIRECTOR
TUNNELS - BRIDGES VIADUCTS - GRADE ELIMINATION
ELECTRIC POWER ELECTRICAL TRANS HYDRO-ELECTRIC
DOCKS - DRY DOCKS
BUILDINGS
WATERWORKS
CANALS
SEWERS - SEWAGE DISPOSAL
IRRIGATION - DRAINAGE FLOOD CONTROL
STREETS - HIGHWAYS
NATURAL RESOURCES EROSION
MISCELLANEOUS (MUNICIPAL)
PARKS - PARKWAYS PUBLIC RECREATION
INSPECTION DIVISION
SUPERVISOR
ENG INSPECTORS
FEDERAL DEPARTMENTS (EXISTING)
R R MAIN & EQUIP
DIRECTOR
COORDINATION WITH I.C.C. FOR APPROVALS
HOUSING DIVISION
DIRECTOR
ASSISTANT DIRECTOR
CHIEF OF TECHNICAL STAFF
CONSULTANTS
TECHNICAL STAFF
FIELD CONSULTANTS
10 DIVISIONS
REGIONAL ADVISORS
STATE ADVISORY BOARD
EXECUTIVE SECRETARY
48 STATES
STATE ENGR P.W
OFFICE ADMINISTRATION
ENGR EXAMINERS
ACCTS. SECTION
LEGAL EXAMINERS
DISBURSING DIVISION
TER. & POSS.
PUBLIC WORKS P.W.A. REPRESENTATIVE
ALASKA
PORTO RICO
HAWAII
VIRGIN IS.
P.W.A. PERSONNEL AS REQUIRED
FEDERAL DEPARTMENTS
FEDERAL PROJECTS FEDERAL DEPARTMENTS AND INDEPENDENT OFFICES
EXISTING FEDERAL ORGANIZATIONS
DEPARTMENTS STATE, TREASURY, WAR, JUSTICE, POST OFFICE, NAVY, INTERIOR, AGRICULTURE, COMMERCE, LABOR, INDEPENDENT OFFICES
INDIVIDUAL CARRIERS
RAILROADS
INDIVIDUAL ORGANIZATIONS (EXISTING)

Engineering News-Record

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Progress At Last

COMPLETION of the Public Works Administration organization for municipal projects, and the beginning of its functioning, is a fundamentally important item of progress. Everyone has reason to rejoice over the news, for it means that the dangerous void which has gradually been forming under the prodigious NRA structure as a result of effect of codes in increasing business expenses without corresponding increase in purchasing power is now beginning to be filled. Real reemployment, not mere labor dilution, will go ahead, both on the job and through orders for materials and supplies that will put new life into the factories. The energetic purpose of the PWA to work fast in pushing projects through to the contract stage is most welcome after the loss of 2½ months of time. It deserves the vigorous support of all who have a hand in public affairs, and though many municipal engineers and officials have become discouraged they are bound to cast off that attitude, now that the machine has been thrown into gear, and give all aid to the rebuilding program. The men at Washington are sincere and earnest in highest degree, and the state organizations have or soon will become imbued with the same spirit. If municipal authorities display similar energy and enthusiasm, plus speed in working out their final plan and application details, the lateness of the season will not stand in the way of rapid large-scale progress. Winter need not and must not stop work. To this end every plan and application should include study of methods and proper allowance of extra cost to carry the maximum amount of construction unbroken through the cold weather.

Desire for Gifts

PROSECUTION of the intensive public-works program is an enterprise in national and local cooperation. It gives no warrant for public panhandling or attempts to raid the Treasury, but calls on citizens and governments to join with a will in the recovery program. National determination has found means to provide more than three billion dollars to help local governments and industry out of the troubles due to unemployment, and this action merits unstinting support rather than the interference of selfishness. Unfortunately, it appears that some local governments are seeking to evade their obligation and throw the whole burden on the nation at large. Grants of the full cost of proposed projects are asked or expected by certain states and cities. One city has officially memorialized the government, saying that it is not satisfied with the allocation of money to build state highways through its streets, and wants more in order that it may be relieved of contributing the 70 per cent share which the Recovery Act fixes as minimum. It does not show that it can increase construction by the loan of additional funds; indeed it does not ask a loan but makes a beggar's plea for local advantage. Somewhat similarly, one state is basing its major public-works plan on the expectation of obtaining full-cost grants and does not want to contribute its own money for the works built for its own benefit. Such instances of failure to grasp the spirit of the present campaign are regrettable. Perhaps they will give way to a healthier spirit and a more honest and progressive attitude as the municipal-projects machine of the PWA speeds up its advance.

Another Research Advance

RATIONAL control of soil compaction in rolled-fill earth-dam construction has been advanced a long step by the laboratory studies and field tests of the Los Angeles water department, to be described in a series of four articles beginning in this issue. Judgment and chance, as they have long ruled in soil stabilization of embankments to impound water or carry loads, are rapidly receding under the attack of research. The soil-stabilization studies of the Bureau of Public Roads have taken the problem of designing stable pavement foundation beds and natural soil surfacings quite outside the realm of uncertainty. Work in the research laboratories of engineering schools and technical associations is rapidly making more certain our knowledge of the stability of deep soil strata under heavy foundations. Quite in step with these older soil-research enterprises is the work of the Los Angeles Bureau of Water Supply in developing the theory and practice of soil stabilization for dams, the scholarly account of which is begun on page 245 of this issue. Technical appraisal must naturally await full presentation of the facts and reasoning; these merit the most careful attention of soil physicists and designers of earth dams.

Yellow River Floods

DURING the past few weeks the daily papers have carried frequent reports of floods and of the widening threat of rising waters along the Yellow River in China. It is stated that the Chinese fear that the river will break through again into the Hwai River valley and return to the channel that it abandoned in 1852. Again this week there are new threats of inundation to the city of Kaifeng and to wide areas in the provinces of Honan, Anhwei, Shantung and Shansi. To the reader unfamiliar with the geography and with the physical characteristics of the rivers of east China (and this includes most readers), these news dispatches convey little definite information from which to gain a clear understanding of what conditions are or what the major developments mean. Because of this general lack of background information, we have asked Arthur M. Shaw, recently returned from a long engagement with the Chinese government, to outline briefly in this issue some of the significant factors relating to the rivers of east China and their flood characteristics. Obviously, it is not possible for him at this distance to give any definite information concerning the current floods; the purpose of his article is to refresh the memory of the reader as to the geography of China and to give him a better background for an understanding of future developments.

Wage and Labor Confusion

WHAT the special board for public works of the Public Works Administration did recently in fixing wage rates to govern all its construction projects adds a significant item to the confusing and unsettling effect upon labor stability which has resulted from various actions of the Washington authorities in the last two months, through their code work and otherwise. The outcome of the confusion promises to be as harmful to labor as to anyone else, in the light of the interdependence of the several elements of our industrial machine.

In the field of construction this confusion is especially prominent. Construction is now under three official wage scales, and a possible fourth: the general construction code scale, the scale or scales for highway construction, the PWA scale, and rates that may be fixed by decision of the Labor Department on the ground of "collective agreements" existing on April 30. As everyone knows, there were no such collective agreements that can fairly be said to represent joint action of construction employers and labor; but once the PWA board has set up the presumption that such agreements existed, it will be easy to claim that certain limited group bargains were true regional agreements of the kind specified. The seductive term "collective agreements" in the Recovery Act, in the NRA codes and in the PWA rulings is a good fighting term. No authority has so far shown courage enough to define it and remove it from the field of contention.

Four official wage rates obviously cannot exist side by side in one locality—except perhaps for a few days or weeks, meanwhile breeding dissatisfaction and the spirit that leads to strikes and blackmail. In a managed economy such as is now being operated in this country, no sensible reason can be found for permitting such wage confusion. The PWA board rate, being the latest addition to the list, is for that reason chiefly at fault, since the board knew of the other previously existing rates and might have been expected to seek harmony rather than add to the discord.

The board's action appears rather unnecessary in view of the successful use of local fixing of rates in the highway program, as carried out last year and this. Local determination of wage rates, done with full regard to local factors and requirements, is natural and logical, while attempts to nationalize construction labor conditions at the present time are hopeless and ruinous. Fortunately the highway rate-fixing system was respected by the PWA board even though it was not adopted. The sorry fact remains, however, that the highway rate system itself may easily be upset by the promulgation of the PWA rates.

Private construction work is more certain to be affected. The PWA rates in some parts of the country are greatly out of match with actual conditions, and therefore will tend to paralyze all work other than PWA —to stop private work and upset city and state work not done with PWA funds.

If the PWA special board thought action on wages necessary, it might have made this action useful and constructive by also regulating working conditions for reasonable efficiency. The same comment, incidentally, might be passed on the NRA, which up to now has made no attempt to couple its wage regulation with an insistence that labor refrain from arbitrary and oppressive regulation of working conditions. Throughout industry, but worst of all in construction, labor has sought and largely succeeded in introducing destructive, wasteful and despotic job practices, which at their worst are fatal to efficient and progressive industry and at their best serve no useful purpose, not even benefiting labor. They have caused a steady deterioration of building quality, which is responsible for a large share of the increase in building cost and the heavy depreciation that unsettles and destroys values.

Had the special board dealt with these working regulations in its ruling, while fixing wage rates, or were it to show a disposition to use its labor control powers with firmness in order to restrain and stamp out these practices, the rate ruling would prove to be constructive rather than trouble-breeding. It would make construction more efficient while increasing wages and wage-earner income.

It seems likely that a firm hand will be called for in dealing with the situation that is sure to develop from this confusion. Whatever possibility of disturbance of construction progress on the score of labor existed before the PWA action has now been made more certain by the special board's rate rule. If the PWA and the associated government authorities act wisely and firmly when such disturbance comes to pass, they may yet save the day and bring about a lasting improvement in construction through eliminating unreasonable working regulations.

In By the Back Door

IS THE federal government planning to go into the power business on a large scale under the guise of creating work under the Recovery Act? Recent developments in Washington raise question on this point.

Under the public-works sections of the Recovery Act the Public Works Board has allocated $50,000,000 to the Tennessee Valley Authority, chiefly for power development through the construction of Cove Creek Reservoir and additions to the Muscle Shoals plant. These two projects will provide the government with 600,000 hp. in the Southeast. More recently $63,000,000 was allocated to the state of Washington for the initial development at the Grand Coulee site on the Columbia, a 700,000-hp. project, and $22,700,000 was authorized to be spent for power and irrigation in Wyoming, a major element of which is the Seminoe Dam with 40,000 hp. Finally, $400,000 has been allocated to the Federal Power Commission for a comprehensive study of power development throughout the country, with special reference to the cost of distribution. Justification for this use of Recovery Act funds for such a purpose is made in the statement that it will enable the NRA to determine whether power developments put up to it for financing fit in with a coordinated plan. That any considerable number of such developments will be put forward as to warrant such a study appears improbable when it is realized that the power to be developed at Boulder Dam is far in excess of the needs of that region, that there is no market for the Columbia Basin power and none for the new power to be developed in the Tennessee Valley. The study looks rather like one to lay the basis for large government-owned power systems. Whether such systems are desirable or not is aside from the point; the government should not be put into the power business on such a scale without definite action by Congress. It should not go in by the back door.

NEWS OF THE WEEK

Construction Code Hearing Date Set for Sept. 6th

THE National Recovery Administration has set Sept. 6 as the date upon which hearings are to begin on the basic code for the construction industry. Deputy Administrator Malcolm Muir will preside over the hearings which are to be held in the Commerce Building, Washington, D. C.

The minimum wage and maximum hour provisions of the code cover both "white collar" employees and manual labor, and provide for the fomer class a minimum wage ranging from $12 to $15 per week, scaled according to the population of the trade area where the work is performed, with a maximum work week of 40 hours. The minimum rate for manual labor is set at 40 cents per hour unless the hourly rate for the same class of work on July 15, 1929, was lower, in which event the rate prevailing on the latter date would be paid, providing it was not less than 30 cents per hour. Under the provisions of the code manual labor may not be employed in excess of a maximum of 35 hours per week during a six-months' calendar period, nor more than 48 hours in any one week or 8 hours in any one day.

The construction industry code was published in full in our issue of Aug. 3, p. 148.

Sub-codes submitted

Nine sub-codes have been submitted to the NRA with the master code for the industry and hearings on them will follow the hearing on that code in the following order: General contractors, architects, master painters, electrical contractors, marble, plumbing and heating, heating and piping contractors, cement gun contractors and building granite. Supplemental codes covering other branches of the construction industry are in the offing but will not be scheduled for hearing until a later date. S. F. Voorhees, chairman of the code committee of the Construction League of the United States, states that every effort is being exerted to hasten completion of such codes.

A meeting of the league's advisory council will be held Sept. 5 at 10 a.m. in Washington to consider suggestions with reference to various features of the master code that have been made since the last meeting.

Pioneer effort in code making

In announcing the date for hearings on this code the National Recovery Administration stated:

"Presentation of the code for the construction industry climaxed a pioneering effort in code making under the National Recovery Act, marking the first instance of an industry of such diversified interests and viewpoints attempting to enlist in the recovery program under a single basic code applicable to all of its many branches, employing in a normal year upward of 5,000,000 persons. For many years efforts have been made to unify the industry. These efforts resulted in failure until the National Recovery Act furnished the medium through which the far-flung and diversified industry could come under a single banner.

Requests to be heard at the hearing must be filed with the Administrator before noon Sept. 5. They must state who the person to be heard represents and must set forth the changes or additions to the codes that are to be proposed.

◆

New York Vehicle Tunnel and Irrigation Projects Get Loans

The Public Works Administration, on Aug. 30, approved an allotment of $37,500,000 to the Mid-town Hudson Tunnel at New York and $15,415,000 to fourteen existing irrigation projects. The loan for the vehicle tunnel is to be to the Port of New York Authority on its 10-year 4 per cent notes.

The loan to the Port Authority is to be used to construct one tube of the projected two-tube tunnel. A sum of $10,000,000 is to be made available for work this year as needed. The Port Authority expects to be able to let contracts for 50,000 tons of cast-iron lining within 20 days after the loan contract is signed and to let the general contracts for the tunnel within two or three months.

Allotments totaling $15,415,000 were made for construction work on fourteen irrigation projects. No project on the list would bring new lands into cultivation. The program will improve agricultural conditions on existing projects without increasing farm acreage. The allotments provide for drainage, replacement of temporary with permanent structures and the improvement of laterals so lands now under contract to receive water can be better served. Funds also were allotted to provide for the construction of storage reservoirs so that lands now under irrigation works may have a more dependable water supply. Half of the projects approved already have been authorized by Congress. The work will be done under the provisions of the reclamation law which provides that such projects shall be self-liquidating. The list follows:

Arizona, Yuma, drainage, $120,000.

Idaho, Boise, drainage, $100,000.

Idaho, Upper Snake River, storage, $4,000,000.

Idaho, Minidoka, Gooding Division, improvement of laterals, $400,000.

Montana, Bitter Root, reconstruction and improvement of laterals, $100,000.

Montana, Milk River, laterals and small structures, $65,000.

Montana, Chain Lakes, dam storage to stabilize existing rights, $2,000,000.

Montana, Sun River, improvements of lateral system, $600,000.

Nevada, Newlands, additional storage, $1,500,000.

Nevada, Humboldt, additional storage, $2,000,000.

New Mexico-Texas, Rio Grande drainage, $500,000.

Oregon, Stanfield, reconstruction of canals, $100,000.

Utah, Hyrum, dam and reservoir, $930,000.

Utah, Ogden, Ogden River development, $3,000,000.

Bridge Pier Failure Wrecks Train Near Washington

Failure of a Pennsylvania R.R. bridge over the eastern branch of the Anacostia River, just north of Washington, D. C., wrecked a limited passenger train about 4 a.m., Aug. 24. Most of the train crossed the bridge, but several cars were thrown into the water; two trainmen were killed by the overturning of the engine. Pending an official report by the Interstate Commerce Commission the accident is attributed to the failure of one pier of the bridge, apparently undermined during the abnormal high water, following a rainfall of about 7 in. The small casualty list is ascribed to the fact that the train consisted of steel cars.

The bridge, on the main line of the railroad and crossed by 72 trains every 24 hours, was a four-span deck plate-girder structure, spans about 60 ft., on a sharp skew (about 45 deg.), and was built about 25 years ago to provide entrance to the Washington Union Station then under construction. The abutments and piers, built of ashlar, were long enough to provide for four tracks. The pier that failed was founded on gravel. The superstructure consisted of two single-track bridges on the middle portion of the piers.

The Southern Railway's southbound Crescent Limited, running on the upstream (right-hand) track, was derailed after all but three or four cars had passed over the bridge, the entire train being derailed to the right. The rear cars were thrown wholly or partly into the stream to the upstream side of the bridge. After the wreck, the middle pier of the bridge had disappeared, and the upstream end of the south pier was broken off just outside the bridge seat, the fragment being tipped toward midstream and upstream; the other pier and both abutments were not affected. Of the four spans that had rested on the center pier the southerly upstream span and northerly downstream span were completely dislodged and under water; the northerly upstream span lay with its north end resting on the northerly pier and its south end submerged 10 or 15 ft. from its original position, while the southerly downstream span lay in the reverse of this position, its north end in the river downstream from original position. The downstream track remained hanging across the gap. The end spans of the bridge showed no injury.

On August 26 a crane, in hoisting cars from the swamp on the west side of the river, uncoupled from the wrecking train, rolled east onto the sagging eastbound trestle and pitched into the stream. Another fatality was added to the toll of the wreck when a railway lineman was crushed to death by a falling pole on which he was stringing a temporary line.

W. P. Borland, chief of the bureau of safety, I.C.C. has assigned G. V. Lovering and J. B. Ford, inspectors, and T. B. Smith, a civil engineer, to conduct an investigation of the accident. The Commission's representatives will question witnesses and submit a report based on evidence adduced at the hearing to be called by the Pennsylvania Railroad in Baltimore, after conditions at the scene of the wreck permit close examination.

Rock Island Limited Wrecked in New Mexico

Another and more fatal bridge failure occurred on Aug. 29 when a structure over a flooded arroyo near Tucumcari, N. M., on the Southern Pacific Lines collapsed under the Rock Island's Golden State Limited. Eight persons were killed and forty injured. At the time of going to press no details were available as to the type of bridge involved or the exact cause of failure.

California Calls For Bids on $4,400,000 of Highway Work

Plans and specifications for 52 California state highway projects, with an engineer's estimate totaling $4,400,000, have been released by the division of highways and bids will be opened Sept. 13, 14 and 15. This work should all be underway before October and will provide about 4,000 jobs. In addition, the highway office is working two shifts a day to prepare plans for another $5,000,000 worth of projects and this work is expected to be started by November.

The largest single project on the first list is a $450,000 job to improve a section of old highway between Sacramento and San Francisco bay, reducing the distance by six miles and eliminating many curves. Another project will improve a section east of Sacramento at a cost of $250,000 and result in completing a high-speed highway all the way over the mountains to the Nevada line.

New Tax Limitations Handicap Public Works in Oklahoma

The entire question of voting of bonds by counties, municipalities and school districts in Oklahoma for public improvements under the terms of the public works act has been thrown into a legal tangle as a result of a vote by the people adopting an amendment to the state constitution reducing the maximum limit on ad valorem levies for all subdivisions of the state and the state government combined from 43.5 mills to 27 mills.

Governor Murray asserts the new limits, which hold cities, school districts and counties combined to an aggregate levy of 15 mills, though school districts can levy 10 mills more by vote of the people, include sinking fund levies on bonds to be voted in the future.

Any such interpretation, if upheld in the courts, would put a stop to most public-works building in Oklahoma, because the 15 mills maximum for general expenses of these three subdivisions is barely enough to meet current expenses after some slashes are made in most budgets.

The question probably will come to a test if the voters of Pottawatomie County approve a $220,000 bond issue, which is supposed to be augmented by federal funds for a $300,000 courthouse. The attorney general must approve the bonds, if voted.

W. A. Bechtel, Contractor, Dies on European Tour

Warren A. Bechtel, veteran Western contractor, head of W. A. Bechtel Co., San Francisco, and president of Six Companies Inc., builders of Boulder Dam, died suddenly in Moscow, Russia, August 28 at the age of 61. Mr. Bechtel, touring Europe with his wife, had gone to Moscow to visit the Dnieprostroy dam. Mrs. Bechtel was in Vienna at the time of his death.

Mr. Bechtel was born on a farm near Freeport, Ill., September 12, 1872. His earlier experiences include cattle ranching, day laboring in a railroad construction camp, and various humble jobs on construction work, principally in Oregon and Nevada. In 1900 he was foreman for Kilpatrick Bros. & Collins on the reconstruction of the Union Pacific in Wyoming. In 1902 and 1903 he was estimator in the Central Pacific Division of the Southern Pacific R.R., and the following year he became superintendent for E. B. & A. L. Stone, of Oakland. In 1906 Mr. Bechtel became a subcontractor for this firm on the construction of the Western Pacific R.R., later doing subcontract work for the Utah Construction Co., on railroad and irrigation projects.

Warren A. Bechtel

In 1914 he started in business for himself, and in the ensuing years specialized in heavy public works, utility and railroad construction. His firm, affiliated with Henry J. Kaiser, is one of the group of six that combined to bid on the Boulder Dam, receiving the contract for $49,000,000, the largest single contract ever let for construction work in this country. In August, 1931, Mr. Bechtel was made president of the combination, succeeding the late W. H. Wattis of the Utah Construction Co. The Bechtel company is also a member of a group of Western firms, known as the Transbay Construction Co., successful bidders on the East Bay substructure section of the San Francisco-Oakland bridge, on which work has just started.

Mr. Bechtel was for long interested in contractors associations, being one of the founders and second president of the Contractors Association of Northern California, which later became affiliated with the Associated General Contractors of America of which he also was president.

Five Cities Get Approval Of PWA Loan Applications

Approved contract forms have been sent by the P.W.A. to five municipalities which had applied for loans and grants to construct waterworks systems. The drafts sent out were mailed to the city authorities of Pahokee, Fla.; Clarkton, Mo.; Fort Benton, Mont.; Spearfish, S. D.; and Newcastle, Wyo. Tentative approval was given these projects several weeks ago. Since then the Administration has satisfied itself that the applicants have met all requirements. After the contracts are signed by the proper municipal authorities they are to be returned to Washington for the signature of the Administrator.

The five loans and grants covered by the contracts involve the expenditure of $226,000, on the basis of a loan of 70 per cent of the total amount and a grant of 30 per cent upon completion of the work in a satisfactory manner. The projects are as follows:

Pahokee, Fla., waterworks	$100,000
Clarkton, Mo., waterworks	20,000
Fort Benton, Montana, waterworks	45,000
Spearfish, S. D., waterworks	41,000
Newcastle, Wyo., waterworks	20,000
Total	$226,000

Under the form of contract the Government reserves the right to inspect all work as it progresses and to have access to all payrolls, records of personnel, invoices of materials and other data relevant to the performance of the contract. All contractors and subcontractors are to report each month to the Department of Labor as to the number of persons on their payrolls and the man-hours of work provided.

Columbus Sewage Plans Rejected By State Health Board

Enlargement of the existing Columbus, Ohio, sewage treatment plant, which had been decided upon by the city council as the method to be adopted to clean up the Scioto River, was rejected on Aug. 18 by the State Department of Health. "General plans" for a complete new sewage plant, submitted by W. P. Halenkamp, city service director, were conditionally approved. Under the plan approved by the city council, the existing plant was to be enlarged to bring its capacity up to 40 m.g.d.

The council has been under orders to appear before the court with a program that the Ohio Department of Health will accept as complying with its order that pollution of the Scioto River be ended.

For some months past the council had been planning on calling for bids on a scheme whereby the sewage plant would be constructed and operated by a private company, but difficulties arose in the way of obtaining a performance bond for such a contract. Representatives of the bonding company stated that it would be impossible for the contractor to obtain a bond unless the requirement in the contract that the bonding company take over and operate the privately owned plant in case the contractor failed to produce satisfactory results were removed.

The present order of the State Health Department is likely to be backed up by the Ohio Supreme Court. Dr. H. G. Southard, state director of health, has insisted throughout that any new sewage construction in Columbus must be designed to become part of a "complete modern plant."

Lumber Code Provides For Production Control And Price Fixing

CONSERVATION of forest resources, control of production and estalishment of minimum prices feature the code of fair competition for the lumber and timber products industry as approved by President Roosevelt on Aug. 19, 1933. The code sets up the "Lumber Code Authority" empowered to administer its provisions. The industry itself is subdivided into 36 divisions, correspondng to categories into which lumber and timber products can be grouped.

Through the provisions of the code the industry undertakes to carry out "such practical measures as may be necessary for the declared purposes of this code in respect of conservation and sustained production of forest resources."

The Lumber Code Authority is authorized to establish and to revise from time to time minimum prices for lumber and timber products, which, except for export sale, shall not be more than the cost of production nor less than such cost of production after deducting capital charges. The capital charges referred to are stated to be depreciation and standing timber carried in capital account. Included in the other items of production cost is the cost of conservation and reforestation.

Production is to be controlled by assigning an allotment to each producer. This allotment is to be determined for a specified period of three months or less and is to be revised from time to time. The allotments shall be based upon an estimate made by the Lumber Code Authority of the expected consumption during such a period and upon the proportion that such person's hourly production, yearly production, number of employees, taxes paid and value of standing timber bears to the aggregate of items for the industry as a whole.

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Private Power License Opposed by TVA

The Tennessee Valley Authority will oppose application by Southern Industries and Utilities, Inc., for permission to construct the Aurora dam and power plant on the lower Tennessee river. This has been announced by Director David E. Lilienthal, in charge of the power phases of the Tennessee Valley program.

W. E. Waldo, president of the utility company which has been working on the site under a preliminary permit, has requested the Federal Power Commission for a 50-year permit to enable his firm to go ahead with its development. Counsel for the Authority will argue against the granting. The preliminary permit expired Aug 17. No hearing date has been set by the Power Commission on the application for a permanent license.

This is the first test of the Authority's opposition to further exploitation of the Valley's waterpower and other resources until a definite conservation policy is worked out. The Authority is of the opinion that Congress intended that the former, being charged with the public's interests, should have exclusive jurisdiction in all future developments on the Tennessee river and its tributaries.

Possible Effect of High Wages on Construction to Be Studied

A study of the possible effect upon construction of higher wages and shorter hours under NRA codes has been begun by the Construction League of the United States. J. W. Taussig, vice-president of the Raymond Concrete Pile Co., New York, has been named chairman of a committee to make the study.

Although the basic code for the construction industry, as prepared by the Construction League, has not been approved by the President, its wage and hour provisions already are being put into effect through modifications of the President's Reemployment Agreement approved on Aug. 11 (*ENR*, Aug 17, p. 208). More recently (ENR, Aug. 24, p. 238) the Public Works Board set up minimum wages for skilled and unskilled labor on all work financed under the public works section of the Recovery Act except highway work. For the latter the state highway departments are to predetermine rates to be paid on highway work in each state. While the rates set by these agencies have no direct bearing on private construction it is expected that they, together with the higher rates and shorter hours to be set under the code for the construction industry, will have an important bearing on the cost of all construction work.

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SOCIETY CALENDAR

AMERICAN ASSOCIATION OF ENGINEERS, annual meeting, Chicago, Ill., Oct. 3-6, 1933.

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, Milwaukee, Wis., Oct. 9-11.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, annual meeting, Chicago, Oct. 17-21.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, Indianapolis, Ind., Oct. 9-12.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS, annual meeting, Milwaukee, Wis., Sept. 25-27.

AMERICAN WELDING SOCIETY, fall meeting, Detroit, Mich., Oct. 2-6.

HIGHWAY RESEARCH BOARD, National Research Council, Washington, D. C., Dec. 7-8.

INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS, annual meeting, Milwaukee, Wis., Sept. 21-23.

INTERNATIONAL CITY MANAGERS ASSOCIATION, annual conference. International House, Chicago, Sept. 18-20.

NATIONAL SAFETY COUNCIL, 22nd Annual Safety Congress, Chicago, Oct. 2-6.

NATIONAL ASSOCIATION OF RAILWAY AND UTILITIES COMMISSIONERS, annual meeting, Cincinnati, Ohio, Oct. 10-12.

NEW ENGLAND WATER WORKS ASSOCIATION, annual convention, Bridgeport, Conn., Sept. 19-22.

ANNUAL SAFETY CONGRESS will be held in Chicago, Ill., Oct. 2-6. Meetings of the Street and Highway Traffic Section will be held on each day of the Congress. Meetings of the Construction Section will be held on Monday afternoon and Wednesday morning.

CANADIAN GOOD ROADS ASSOCIATION will hold its 20th annual convention at Hamilton, Ont., Sept. 13 to 15.

CALIFORNIA SECTION, American Water Works Association, will hold its annual meeting at Oakland, Calif., on Oct. 20-24.

MISSOURI VALLEY SECTION, American Water Works Association, will hold its annual meeting at St. Louis, Mo., Oct. 26-28.

NORTH CAROLINA SECTION, American Water Works Association, will hold its annual meeting at Statesville, N. C. on Nov. 6-8.

Washington Notes

By Paul Wooton
Washington Correspondent

Unless loans to municipalities can be expedited, the Public Works Administration will not be able to get much work started before cold weather makes construction difficult. In an effort to hasten along municipal work of type most suited to the program, Administrator Ickes has appointed Paul V. Betters, executive secretary of the United States Conference of Mayors, as liaison officer between the federal government and the cities. The United States Conference of Mayors includes practically all of the cities over the 100,000 population mark.

This appointment is expected to be of material aid in straightening out misunderstandings that arise under the act—especially those of a technical nature. Mr. Betters is an acknowledged authority on municipal finance and operations. Many cases have come up in which municipalities are so circumscribed by state law that it is impossible for them to comply with some of the federal requirements. With a knowledge of the difficulties in such cases, the Public Works Administration will be able to handle the applications more sympathetically and soften some of the provisions where state and federal law conflict.

Belated orders for more speed on the public works program increased the confusion this week as federal agencies, such as the reclamation service, to which large allotments have been made, have not been informed on how to proceed. Other bureaus are loath to spend their allotments quickly because they do not know when they will get more funds. With reference to the federal agencies, Secretary Ickes stated this week that "we can only bedevil them into action."

Local project proposals are beginning to come in from the state boards and in order to get work started quickly when approved, the public works board is giving consideration to inclusion of a forfeiture clause in the loan contracts. The legality of such an expedient still is being studied.

After several weeks of delay, the public works board has allotted $36,986,956 to the Corps of Engineers for flood control work on the lower Mississippi River. This will cover only urgent levee work, according to the engineer corps, but no more allotments for the lower river will be made from the emergency public works fund. An allotment of $7,000,000 was made several weeks ago.

An allotment of $13,600,000 to the Navy department for construction and repair work at shore stations and navy yards may be supplemented at a later date. Projects selected were those on which work can be undertaken without delay by the Navy Bureau of Yards & Docks.

An allotment of $8,501,190 was made to the Treasury Department for construction of six coast guard cruising cutters and four harbor craft. Other allotments included $515,000 to the veterans' administration for building construction and repair; $93,845 to the Department of Justice for alterations at Washington, D. C., National training school for boys; $25,000 to the War Department for improvements on the Statue of Liberty; $32,000 for a water system in Arlington National Cemetery and $3,000 for a water system in the Santa Fe National Cemetery; and $104,150 to the office of public buildings and parks for park sewers and building improvements in Washington, D. C.

The allotment for flood control will be apportioned as follows: $33,986,956 for construction and $3,000,000 for obligations in the new Madrid floodway and for rights of way in Arkansas on the Red River and in the Atchafalaya Basin. These obligations are the result of court decisions and cannot be suspended. The Memphis District will receive $17,720,400 for construction, the major part of which will be spent on levees on the river, including Birds Point to Cape Girardeau and levees at Mounds, Hickman and south of Tiptonville. The New Orleans District will receive $9,574,156 for construction, of this amount $3,960,000 will be spent on levees in the Atchafalaya Basin. The Vicksburg District will receive $6,692,400 for construction, including levees and revetments and stabilization.

The allotment for the Navy Bureau of Yards & Docks will be apportioned as follows: $4,500,000 for construction and improvements at Pearl Harbor, Hawaii; $1,010,000 at Pensacola, Fla.; $1,455,000 at Puget Sound, Wash.; $549,000 at the New York Navy Yard; $168,000 at the Mare Island Navy Yard, Calif.; $383,000 at the naval air station, San Diego, Calif., $325,000 at the Washington, D. C., navy yard, $72,000 at the submarine base, New London, Conn., $100,000 at the Philadelphia Navy Yard, $50,000 at the Naval War College, Newport, R. I., $465,000 at the Norfolk, Va., Navy Yard, $40,000 at Coco Solo, Canal Zone, and $575,000 at the Naval Academy, Annapolis, Md.

Secretary Ickes described as a formality President Roosevelt's executive order of August 19 vesting in Mr. Ickes, as administrator of public works, the full authority conferred by Title II of the National Recovery Act. Secretary Ickes brushed aside reports that the President's action was taken to give the administration a free hand independent of the public works board. The board has never been anything more than advisory, according to Secretary Ickes. He said that so far all allotments of funds have had the unanimous approval of the board.

Secretary Ickes does not regard as pressing the proposal to allocate more funds to road building than the original allotment of $400,000,000.

The public works administration is searching for personnel to staff a committee on erosion prevention. This organization will be separate from the PWA proper. It will work in conjunction with the coastal erosion commission and the bureau of agricultural engineering but its scope will be wider than that of the other agencies.

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Tower Erection Equipment Arrives For the Golden Gate Bridge

Steel for the tower traveler to be used for the erection of the 740-ft. towers of the Golden Gate bridge has arrived at the site by boat from the east and is now being erected at the Marin (north) pier. This pier has been completed for several weeks and as soon as the first shipment of steel arrives Sept. 4 the tower erection will be started. The hoists which form part of the erection equipment were those used on the George Washington bridge, New York.

Public Works Funds Allotted For Missouri River Improvement

An allotment from the public works funds of $14,153,108 for work on the Missouri River has been announced by Public Works Administrator Harold L. Ickes. The allotment provides for completion of the project between Kansas City, Mo., and Sioux City, Iowa, providing for the improvement of the Middle Missouri River by the establishment of revetment and dike systems to stabilize the navigation channel.

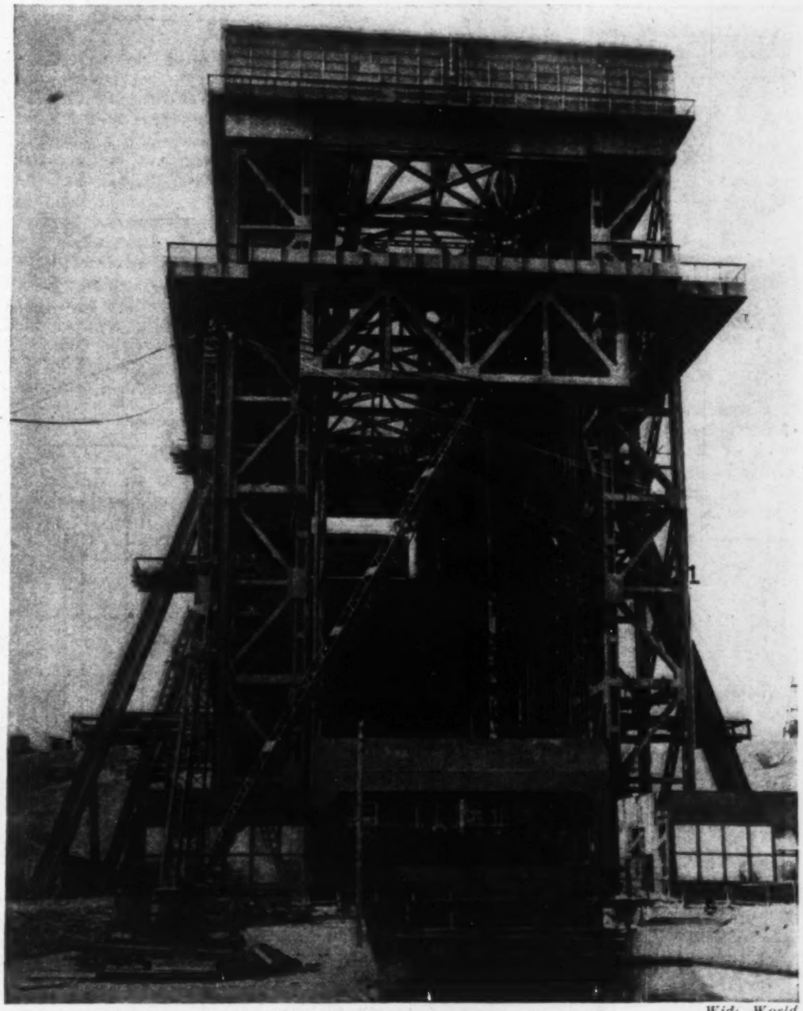
About $2,000,000 will be expended between Kansas City, Mo. and St. Joseph, Mo., and the remainder on that part of the river between St. Joseph and Sioux City, Iowa.

The work will be done under the direction of the Secretary of War and under the supervision of the Chief of Army Engineers.

Sanitary District Established For St. Paul and Minneapolis

Another step toward the construction of the St. Paul and Minneapolis sewage disposal system was taken on Aug. 22 when the State Board of Health held a public hearing and passed a final order creating a sanitary district of the two cities to construct a sewage disposal system to eliminate pollution of the Mississippi River (see *ENR*, July 29, 1933, p. 89). No opposition to the project was expressed.

This order will now be filed with the District Courts of Hennepin and Ramsey Counties, and a period of 30 days must elapse before further action is taken to give taxpayers of the district an opportunity to file protests. The next step will be the appointment of a Board of Trustees of seven members, which will take over the actual management of the project, including its financing.



Wide World

BARGE LIFT FOR THE BERLIN-STETTIN CANAL

A barge lift to transport barges through a vertical distance of 36 meters (118 ft.) is nearing completion near Eberswalde in Germany. It will replace a flight of four locks in the existing canal between Berlin and Stettin on the Baltic where the canal comes down to the Oder River. Reconstruction of the canal is being undertaken as part of a program of canal reconstructions to permit the passage of 1,000-ton barges from the Rhine River across Germany to Stettin and Danzig on the Baltic. An outline of this canal system was given in *ENR* June 23, 1932, p. 893.

The accompanying view was taken with the elevator tank in lowered position showing the numerous suspender cables. The tank is 80x12 meters in plan and 4 meters deep. In its raised position it connects through gates with an aqueduct of steel reaching from the lift to the canal proper on the high land in the background.

Personal Notes

Christopher J. Carven has been appointed commissioner of public works for Boston, Mass. Mr. Carven succeeds Louis K. Rourke, who died on Aug. 23.

Willard T. Chevalier, publishing director of *Engineering News-Record*, has been named industrial advisor to the NRA for the Crushed Stone, Sand and Gravel, and Slag Industry.

Harry S. Rogers, since 1927 dean of the school of engineering, Oregon State College, Corvallis, has announced his resignation of that position to accept the presidency of the Brooklyn Polytechnic Institute, Brooklyn, N. Y. His successor at Oregon State College has not been announced. Dean Rogers came to Oregon State in 1920 from the University of Washington as professor of hydraulic engineering.

Alonzo J. Hammond, president of the American Society of Civil Engineers, has been chosen General Chairman of the Construction League of the United States, succeeding Robert D. Kohn, who relinquished the position because of having been selected as head of the Housing Division of the Public Works Administration. Mr. Kohn has served as chairman of the League since its formation two years ago and played a determining part in formulating the policies under which the League became a central forum of the construction industries. E. J. Russell, president of the American Institute of Architects, has been named first vice-chairman of the League, succeeding Mr. Hammond.

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Correction

A personal note published in this column in our issue of July 27 reporting the retirement of J. W. Link was in error. Mr. Link's retirement occurred early this year. He died on April 14, as reported in our issue of April 20.

Contracts and Capital

CONSTRUCTION

(Thousands of Dollars)

	Weekly August, 1932	Average Four Weeks	Week Aug. 31 1933
Federal Government..	$4,177	$732	$427
State and municipal..	12,440	7,606	11,060
Total public.......	$16,617	$8,338	$11,487
Total private......	3,792	7,199	7,628
Week's total.......	$20,409	$15,537	$19,115
Cumulative to date:			
1932..............		$823,104	
1933..............		570,336	

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

	Weekly August 1932	Average Four Weeks	Week Aug. 26, 1933
New capital issues....	$5,400	$79,022	$31,871
Cumulative to date:			
1932..............		$517,600	
1933..............		658,106	

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ENR Cost and Volume Index

E.N.-R. Cost		**E.N.-R. Volume**	
August, 1933..	**167.00**	**July, 1933.......**	**65**
July, 1933.....	165.50	June, 1933........	109
August, 1932...	156.80	July, 1932........	166
1932(Average).	156.97	1932 (Average)...	127
1931(Average).	181.35	1931 (Average)...	220
1930(Average).	202.35	1930 (Average)...	260

1913 Average.......... 100

Obituary

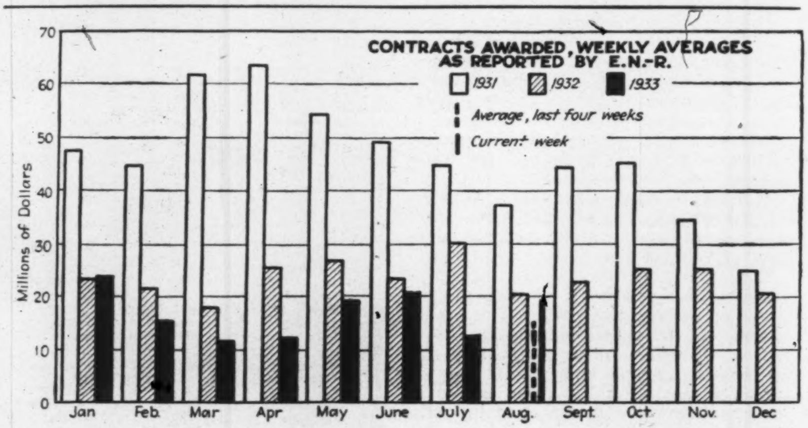
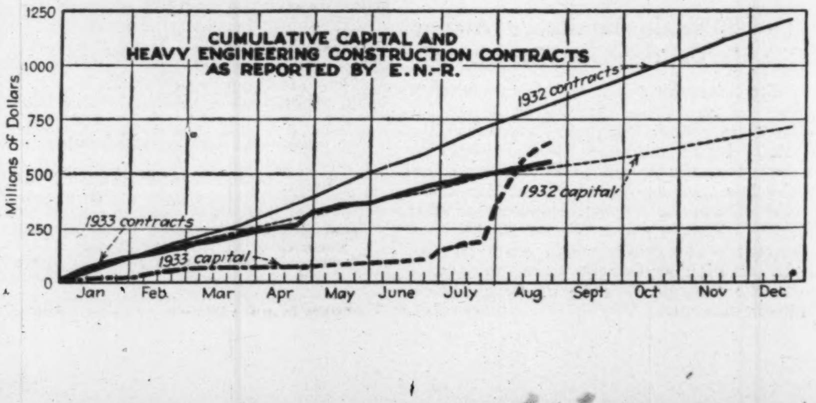
Raymond J. Smith, age 47, assistant chief engineer of the maintenance bureau, Ohio Highway Department, died Aug. 21 at his home in Columbus from heart trouble. He was formerly county surveyor of Champaign County, Ohio.

Louis K. Rourke, former commissioner of public works of Boston, Mass., died at his home in that city on Aug. 23 at the age of 59. He was a native of Abington, Mass., and was graduated in 1895 from Massachusetts Institute of Technology. His early career included service in the Boston & Maine, Panama and Guaquil and Quito Railroads. In 1910 he became superintendent of streets at Boston, being placed at the head of the public works department upon its organization.

Charles Oscar Vandevanter, formerly chief engineer of the Western Maryland Railroad, died at his home at Leesburg, Va., on Aug. 14 at the age of 84. Mr. Vandevanter entered the first class organized at the Virginia Military Institute after the close of the Civil War and was one of the first graduates to be awarded the degree of civil engineer from that institution. He started his engineering career as a rodman on the Portland & Ogdensburg Railroad in 1870. Most of his 45 years of active engineering practice was devoted to railroad construction and maintenance. He was chief engineer of the Western Maryland Railroad for a number of years and later served as chief engineer of the United Railways & Electric Co. of Baltimore, Md. He was also at one time assistant engineer of the City of Baltimore.

Engineering Contracts and Capital

With highway lettings aggregating $8,592,000, the heaviest since early January, heavy engineering construction contracts reported last week rose to $19,115,000, the highest since the week of June 29, and a 50 per cent increase over the average of the past two months. The spurt in highway awards indicates that the $400,000,000 federal highway program is getting under way. Last week New York state awarded road contracts totaling $2,661,000, and Montana followed with highway lettings aggregating $1,433,000. Public works awards last week totaled $11,487,000, the heaviest since June 22, though federal contracts amounted to only $427,000. Private contracts rose to $7,628,000, following a $5,000,000 total the previous week. Included in this class were two large contracts, one for a potash works, Trona, Cal., $1,250,000, and a $2,200,000 award for a gas pipeline in Arizona. Cumulative contracts to date this year total $570,336,000, about 70 per cent of the volume reported last year for a similar period.

Including federal grants and loans for other than strictly federal government projects, new productive capital figures reported the past week amount to $31,871,000, bringing the cumulative total for the year to $658,106,000, as compared with $517,600,000 reported to the corresponding date last year.